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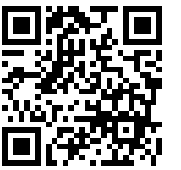

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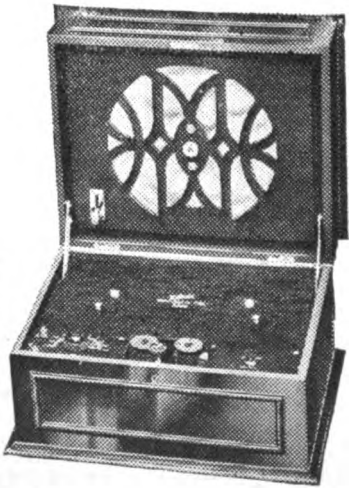

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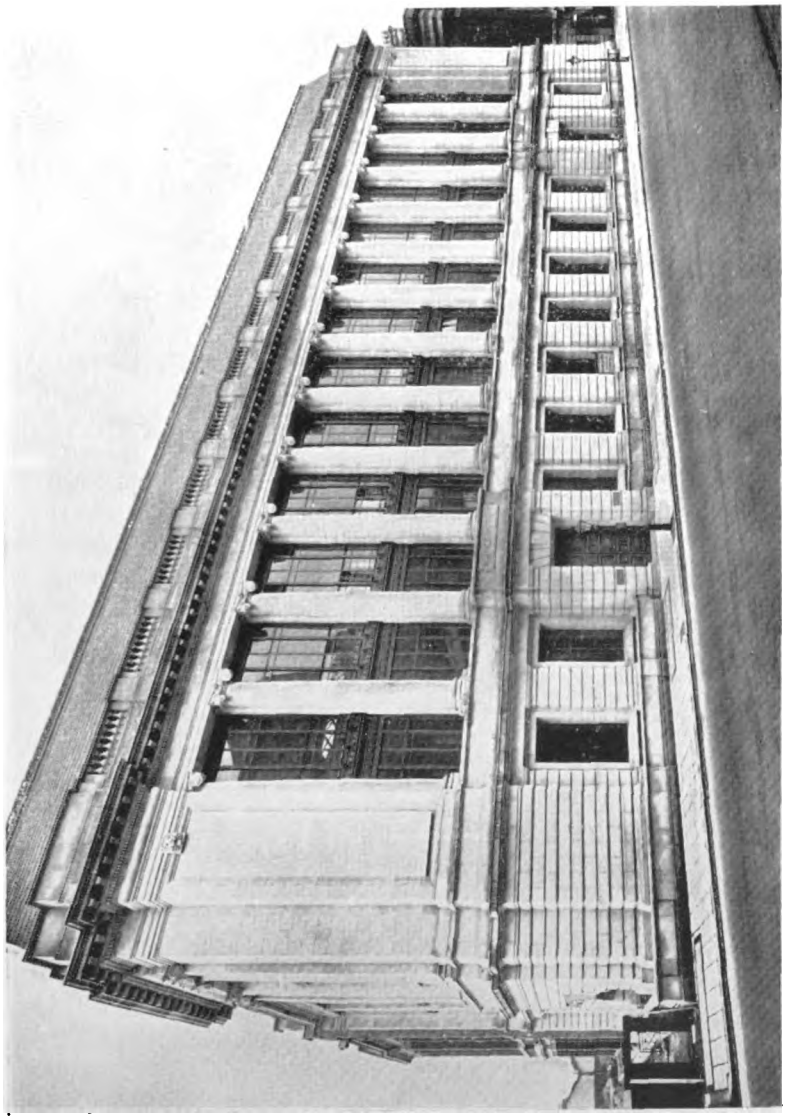

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FORTIFICATION IN WAR.

A Lecture delivered at the S.M.E., Chatham, on Oct. 20th, 1927.
By MAJ.-GENERAL SIR EDMUND IRONSIDE, K.C.B., C.M.G.,D.S.O., *p.s.c*

TO-NIGHT I propose to deal almost entirely with the strategical aspect of fortification in war, and I shall barely touch upon the technical side of the question.

If we trace back the history of fortification in military operations, we find its first uses in expressing the desire of peaceful people to protect their worldly goods against the lawless. Also, the lawless themselves made use of it to strengthen their homes, so that they might go out on their forays in the fullest strength. Thus arose the walled town and the strong castle. As the world became more civilized and nations arose, we find these two forms of fortification developing into the entrenched camp and the border fortress Campaigns at first were undertaken for the reduction of one or more strong places. Slow and leisurely campaigning became the rule, and the number of fortresses grew rapidly. With the advent of standing armies, the value of these strong places declined, for these armies were made ready for war much more quickly than the old levies, and campaigns were won and lost without much effect having been exercised upon them by the fortresses. It became evident that it was uneconomical to shut up large numbers of men in strong places and so weaken the forces actively engaged. Nations examined the situation of their fortresses and drastically reduced them in number.

If we take the French and Belgian fortresses as an example, we may draw some very definite conclusions from their geographical positions. They were constructed under a certain sense of inferiority. Neither France nor Belgium—at the time of the construction of these fortresses by Rivière and Brialmont—were aggressive from a military point of view. Both felt that they were inferior in readiness for war to their possible enemies, and so they resorted to fortification to gain the necessary time for preparation. You will see that the fortresses form a kind of barrier closing the communications leading from the enemy into the heart of the home country. That these fortresses have been constructed on or in extension of older works is explained by the fact that communications naturally run towards important towns, which were in the old days surrounded by walls.

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In 1914, it cannot be said that any of the French and Belgian fortresses were up-to-date. Technically, their component forts were unable to resist the bombardment of modern artillery. In fact, generally speaking, it may be said that artillery science had definitely gained the upper hand of engineering science. But it was not only in this technical way that the fortresses were out of date. The range at which modern artillery fired had been so greatly increased that the fortresses no longer covered the points which they were designed to protect. If you take the map of Belgium and study our operations at Ypres you will see what I mean. Heavy traffic was confined to the paved roads, for to have used the unmade roads extensively would soon have involved you in a sea of mud. To have lost Ypres would have meant that we would have lost a most important junction of good roads. We should have had to use Poperinghe more extensively. To have lost Poperinghe would have been even a greater disaster, for we should then have had no good roads in the triangle between Rousbrugge—Cassel and Bergues. For the proper protection of Ypres we should have liked to have been further out than we actually were, and we were continually struggling for more elbow-room.

Military engineers realized fully the shortcomings of their fortresses and had many times demanded an overhaul of the barrier of fortification. Money is always at the bottom of all questions of military efficiency, and large sums of money must be expended in fortification works. These works take a long time to erect, and are often obsolete before completion. One therefore sees a continual process of tinkering going on—which leads in fact to a good deal of expense and little permanent betterment. This tinkering is plainly to be seen in the fortresses under discussion.

With all its inferiority, however, the French line of fortifications had a most important effect upon the course of the Great War. You will see how short is the common frontier of France and Germany. It is only 140 miles as the crow flies—not a great breadth, even if left completely open, for the deployment of the great army which Germany would place in the field. Germany's plan of action embraced campaigns in both West and East. A throwing of her main forces against France first, and then a return to the facing of her more slowly developing enemy, Russia. A quick victory over France was essential for final success. The frontier, fortified as it was, did not suit Germany's strategical conception of an advance, envelopment of the enemy by one or both flanks. She would not therefore face the French fortifications, since both time and geography were against her. She decided to attack France by means of a great enveloping movement through Belgium. Here, then, is a very definite effect of fortification upon strategy. Germany's fear of facing the French fortifications was in the end her undoing, for it brought in the British

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Empire against her, and the brutal violation of Belgium lost her the sympathy of the whole civilized world. Moreover, the German General Staff miscalculated the effect on newly-mobilized troops of marching for weeks on end, and there can be no doubt that their plan did not take into account to a sufficient degree the administrative difficulties of such an operation.

Though Germany had avoided the French line of fortifications, her plan compelled her to deal with the Belgian fortresses. Let us examine the position of Liége. The Meuse, running as it does, divided the flat Brussels plain from the hilly and wooded Ardennes. It was essential for the Germans to cross the Meuse and gain access to this plain. The fortresses of Liége and Namur blocked the main crossings over the river. The crossings at Liége were the most important, for the Germans wished to spread out their columns on a broad front as quickly as possible. There can be no doubt that the Entente laid great hopes on Liége, and expected that it would delay the Germans considerably, should they come that way. There are several reasons why this delay was not secured in actual fact. Belgium was caught unawares. She received an ultimatum one moment and was attacked the next. Her army hardly knew whether the Government had decided to oppose the Germans or not. But, there were two main reasons for ill-success. The fortress consisted of a ring of isolated forts supporting each other with gun-fire. The forts were placed so as to block the main roads running into the bridges in the town, but there were no completed defences between the forts. The Germans, in their surprise attack, managed with one of their columns to penetrate between two of the forts and secured the precious bridges within. They secured these bridges intact long before the forts were finally reduced by the fire of heavy artillery. It had been the intention of the military authorities to complete the defences between the forts after mobilization. In this, of course, they failed for want of time. The second, and perhaps the more important reason, for failure, lay in the faulty employment of the field troops. The Division which should have operated with the fortress was withdrawn to the West, and the fortress was left with its own garrison only. There were probably mobilization reasons for this withdrawal, but the fact remains that, had the field troops been present in Liége, the Germans would never have penetrated into the town, and they would never have secured the bridges intact. Here, then, is a good lesson. Fortresses by themselves do not repay the money spent on them. They should be used in order to facilitate the operations of the field army.

The German method of dealing with Namur and Maubeuge was different to that employed at Liége. The communications they were guarding were not of the same immediate necessity to the Germans, and, therefore, it was decided to overrun them, isolate them, and

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reduce them at leisure behind the main advance. In this the Germans were completely successful. Neither of these fortresses could stand up to the bombardment to which they were subjected. They were unable to affect the German advance either as regards the front troops or the building up of the line of communications behind.

The cases of Antwerp in Belgium and Königsberg in East Prussia are also interesting. Their positions in regard to the two great advances were precisely the same. They lay away to the right flank. They neither of them could be isolated, for they both could be reinforced by sea, the first from the Belgian coast and the second from the sea canal from Pillau. Antwerp was considerably stronger than Königsberg, but the Russians did not possess any heavy artillery in East Prussia. The Commanders of the two great advances treated the fortresses in very different manner. The Germans at first paid little attention to Antwerp, and merely observed it, strengthening the forces of observation as danger threatened. They did this despite the fact that it was well known that the Belgian army intended to withdraw within the fortress. The Russians prepared to blockade the area of Königsberg and to wait till guns were available from the Austrian theatre before they reduced it. They had no idea whether the Germans would allow any of their field forces to shut themselves up in Königsberg and made little attempt to find out the actual situation. They employed a force for the blockade greatly superior to the German forces within the fortress, to the detriment of their field forces continuing the advance.

A position to a flank, such as these two fortresses enjoyed, is an advantage not to be despised, but one can exaggerate the importance of such a situation. It is very difficult to organize a sortie from a fortress, more especially if the troops have already been engaged and defeated in the field. One has only to examine the stories of the sorties from Paris and Sedan to realize the truth of this.

Now let us take the situation of Paris. Here we have a great entrenched camp in the centre of France. It is, indeed, the centre of communications, both road and railway. Here was an area of over thirty miles, stretching from East to West right across the German right wing's advance. In this area the French could manœuvre and the Germans could not. What was von Kluck to do when he came within a few days' march of this area? Was he to go to the East or the West of it? If he went to the East he laid himself open to an attack issuing from Paris against his right flank. If he went to the West he would be separated by several days' march from the army next to him. As you all know, he went to the East and was attacked in right flank by Manoury.

The lesson of Paris is that the field armies employed it at exactly the right moment as a pivot of manœuvre. Had the Battle of the Marne taken place further south, Paris would have lost its value in

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impeding the Germans, who would have isolated it and reduced it at their leisure.

There is always a difficulty in getting retreating troops to stand at all, and there is perhaps greater difficulty in choosing the correct moment at which to stand, but the Battle of the Marne will always stand as an example of wonderful timing under difficult conditions. The question of the deliberate withdrawal of an army in order to use pivots of manœuvre inside one's own territory has been much debated. It should never be forgotten that Governments and peoples are only human, and that they do not like giving over territory to an enemy, however great may be the strategic advantage. The French retreat was in no way a voluntary one. They were caught at a disadvantage and carried out an improvised manœuvre of great difficulty with brilliant success.

If anybody has any doubt as to the value of the French fortifications—obsolete as they were—let him examine the final line attained by the German advance in 1914. You will see the very definite bulges in the line made by the fortresses of Nancy, Verdun and Paris. There can be no doubt that these fortresses, used in conjunction with the field forces, did prevent disaster. (*See Sketch.*)

Now let us turn to the future. I have no desire to pose as a prophet, which is a thankless task indeed. As you know, it is the aim of all good strategists to prevent a campaign from developing into such static warfare as occurred in 1915–16–17. Armoured fighting vehicles have certainly come to stay and, whatever may be the degree of one's belief in them, one must admit that there is more likelihood of periods of mobile warfare in the future. That there will also be long periods of halt is equally certain, for no administration could possibly keep pace with continuous fast movement at the rate of modern motor transport. The three main factors which will bring about these periods of static warfare are—lack of machines, lack of petrol, and modern fortification. As I have already pointed out to you, fortresses have always been built to control communications, and with mobile warfare communications are more important than ever. However much one may desire to see an army supplied with complete cross-country transport, such an achievement is beyond the purse of any nation in peace-time. The bulk of the vehicles employed will be wheeled vehicles used by the nation in peace-time. The main principle governing our method of fortification must be the denying of road communications to the enemy, while retaining them intact for ourselves.

I have shown you some photographs of fortresses taken from the air by foreigners against our will and desire. From these you will realize the difficulty of concealing anything in the way of permanent fortification. With the present power and range of artillery, it will always be possible to reduce the best of forts, given the requisite time,

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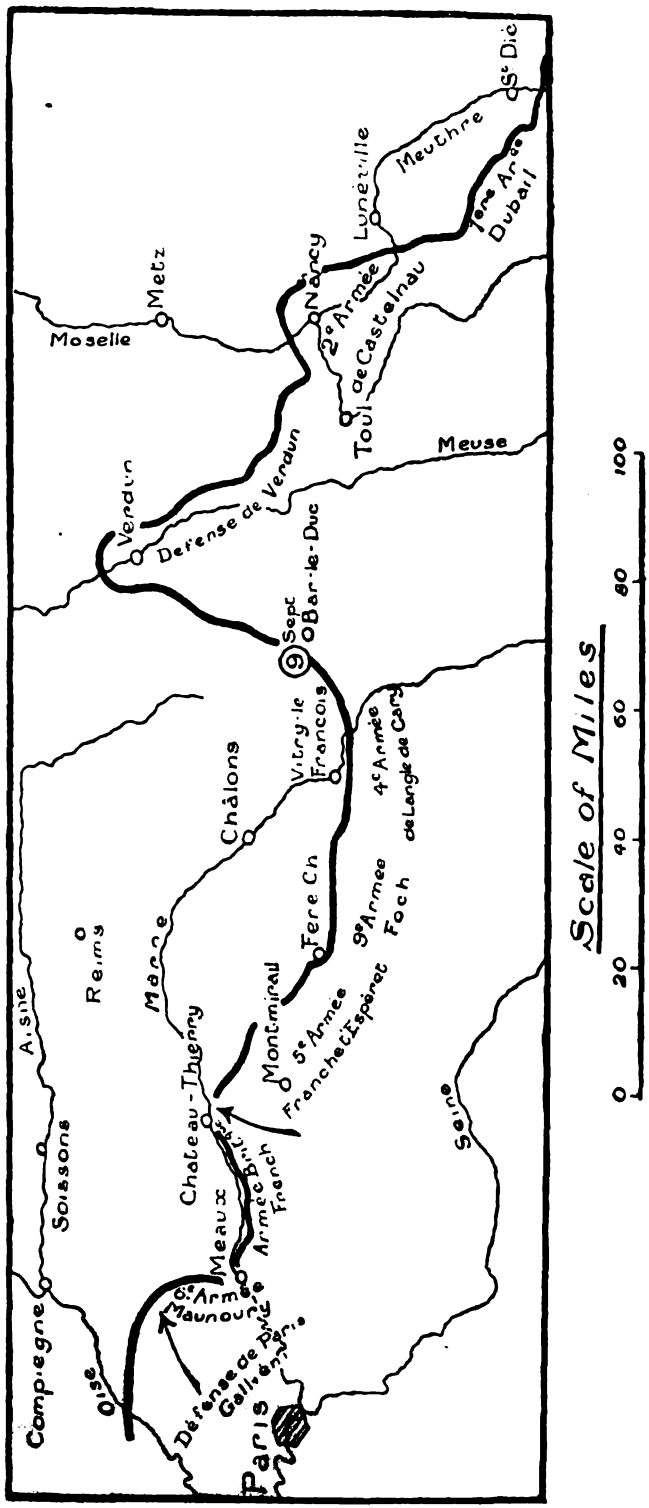

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and this time will be reduced considerably if the enemy has accurate knowledge of the position of the fortifications he is going to attack. Is it worth while, therefore, embarking upon fortification of this expensive nature? I do not think it is, unless the actual geographical position of the chosen fortress is very favourable, such as would be the case in some of our isolated oversea possessions.

One cannot exaggerate the importance of the principle that whatever fortification is employed must be for the direct benefit of operations in the field, and must be so situated that it can be readily turned to account under several different strategical conditions. The importance of natural obstacles—such as rivers, lakes and forests—has certainly grown immensely. It seems to me that we ought to use these natural obstacles to the fullest extent, widening the area of their effect by means of fortification. We must employ some kind of pill-box defence, making whole areas impervious to anything but regular bombardment. What we require is something which can be put quickly into execution and which cannot be easily reconnoitred by the enemy. I have a vivid recollection of the pill-boxes erected by the Germans inside ordinary houses. It was not till we began to bombard in earnest that the houses fell apart to reveal the horror within.

In considering a modern theatre of war, I should attempt to analyse it as follows. There seem to me to be three distinct areas, the Base area, the Aerodrome area, and the Front area. The Base area will consist of one or more entrenched camps. Here one will find more or less permanent fortification, always the best adaptation of old and obsolete fortifications. The Aerodrome area will be something less permanent. It will contain the aerodromes for the aircraft working with the armies in the Front area. It will certainly be of large extent and may consist of one connected area or of several distinct areas with intervals between them. The Aerodrome area must be situated at an economic distance behind the Front area, or the machines will expend their energy unduly before coming over the fighting forces in front. The Aerodrome area must be capable of being moved forward by bounds. By saying this I do not mean to say that there will be much movement of aerodromes, for they are bulky to move with all their stores of bombs and petrol. When the distance between the Aerodrome area and the Front area begins to increase, recourse must be had to advanced landing-grounds, which will not require so much protection. Movement of the Aerodrome area will be by big bounds. If we protect the Aerodrome area as I suggest, we can use it as a pivot of manœuvre for the fighting troops and also as a haven of rest for the transport working from the Base area to the Front area. This seems to me to be the only method by which one can free the fighting troops for mobile operations. A

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Commander can perhaps cut himself off from his communications for a period, but he cannot abandon them altogether. If he is thinking always of his rear he will not handle his troops sufficientiy boldly

I should like to say a word about what we call combined operations. The matter is closely connected with the defence of our oversea fortresses. It should be remembered that we are the only nation which has much experience in these operations. We have made many mistakes in the past, but we have collected a vast experience in the subject. We realize that they are the most difficult of all operations of war. We can console ourselves that other nations are mere amateurs at the game when compared with us. It is the very isolation of an overseas fortress which constitutes its great strength. To attack one is a serious operation. I will give you an instance of one of the difficulties. The attacker will always find it difficult to gain superiority in the air, even if the fortress is meagrely supplied with aircraft. It is necessary to find a landing ground if you are going to use wheeled aircraft and this will entail a preliminary operation. If the defender of the fortress is alive to the situation he will turn your preliminary operation into a main operation, and will use his aircraft to prevent you establishing yours. If you propose to use aircraft with floats and to use some piece of water as a landing-ground, you will find your machines inferior in air performance to the land machines of the fortress. To use naval aircraft-carriers off a coast is a ticklish affair, not relished by the seamen, for they have to steam at high speed into the wind to take on their machines.

You will see that I am of opinion that the day of fortification is by no means over. I think, however, that they will be of a more improvised character, and much more extensive than has been the case in the past.

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A WINTER IN WAZIRISTAN.

By BRIG.-GEN. H. H. AUSTIN, C.B., C.M.G., D.S.O.

II.

MULLAH POWINDAH'S impassioned appeal met with little response, though an Afridi ***havildar*** (sergeant) and several sepoys had previously deserted from one regiment at Wana a night or two after the Mahsud attack on the Delimitation Escort camp. These trans-frontier men had gone off with their Martinis and a goodly supply of ammunition, obtained chiefly by a clever ruse from the other sepoys on picket duty that night. The ***havildar***, a noted shot in this regiment, was now credited with being the Mullah's right hand, and the leader of the ***budmashes*** who had been firing continually from long ranges on the different columns operating in the country. Active as he and his gang had certainly been, their efforts, unsupported by the Mahsuds as a whole, were not likely to affect in any way the intentions of the Commander of the Field Force.

The Wana brigade now received orders to return to Wana, *via* Tank and the Gomal river route; the Bannu brigade was directed to proceed across country to Bannu, and thence up the Tochi Valley; whilst the Jandola brigade pushed west up the Shahur Zam to Kundiwam in the Khaisera Valley, some thirteen miles to the north-east of the former Wana camp. At Kundiwam a large *jirgah* (council) was to be held by Sir William Lockhart about January 20th, and if the Mahsud ***maliks*** then displayed signs of accepting the terms of Government the delimitation of the new frontier with Afghanistan was to be taken in hand at once.

The physical difficulties lying in the path of the Jandola brigade were known to be great; so both the 2nd and 5th Companies, B.S. and Miners, were attached to it for the purpose chiefly of road-making. Accompanied by an escort of an Indian battalion, they left Jandola on January 11th for Haidari Kach, distant eight miles up the Shahur; and during the next two days they were hard at work improving the rough track along the river bed for the passage of the main body and transport at Jandola. The Shahur joins the Takki Zam a short distance above the post, and almost immediately after entering it the cliffs commence to close in and culminate in the Shahur Tangi, some three miles up-stream of the junction. The defile is a very narrow one and shut in by lofty sandstone precipices;

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whilst rocks and boulders in the bed had to be blasted and regularized to render the route through practicable for camels in single file. In other places ramps had to be made from the river bed on to small *kaches* and then down again, in order to avoid particularly bad stretches in the bed.

Thus, the main body and transport were able to march comfortably through to our camp at Haidari Kach on the 13th; and next day the whole force proceeded together to Nana Khel Kot, another eleven miles on. We passed two tempting walled-in villages with towers, and several water-mills, but these, the Politicals said, belonged to "friendlies." They were spared, although our field telegraph line from Jandola had been cut twice at night during our three days' stay at Haidari Kach. Still, we had plenty to occupy us otherwise, for several plateaux had to be crossed to cut off sharp bends in the stream, which necessitated the rapid construction of roadways up to and down from these tracts of high ground. On the whole, however, the going was fairly good, as the country hereabouts opened out appreciably; so all the camels reached the new camping-ground by daylight, which was a welcome change to the normal state of things.

Continuing next day along the bed of the stream, the hills closed in again; and though *kaches* existed at intervals, the river became much confined where joined by two other rocky ravines in the vicinity of some hamlets and water-mills. Nevertheless, the transport animals were got safely through this defile; but eight miles after leaving Nana Khel Kot the force was confronted by an impassable *tangi*. We were compelled in consequence to clamber up to a plateau 150 ft. above the river in order to find a spot whereon the brigade could camp, Para Khel Kot by name.

The road to Kundiwam by the bed of the stream was effectually barred by an amazing cleft in the mountains. The hard limestone cliffs on each side rose almost vertically for several hundred feet out of the shingly bed of the river, and were separated by a space of only a few feet. In the fifty or sixty yards' length of this striking slit the shallow stream pursued a sinuous course; and almost in the centre of the gorge the cliffs closed in until they were less than five feet apart. Here an immense rock, an irregular diamond in shape, had fallen from the frowning heights above and was firmly jammed across the narrow aperture. Sufficient headway remained for a person to walk underneath, but no laden camel could possibly pass between those immovable walls.

The up—and down—stream approaches to the *tangi* were strewn with great boulders; and for another two and a half miles up-stream the bed of the Shahur was chiefly a confused mass of more boulders and huge rocks, some nearly as big as cottages. Thus, even had not that grim sixty yards of lower *tangi* existed, the construction of a

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camel track through that chaos of rocks and water leading to Kundiwam beyond would obviously involve much labour and time. And of the latter there was little to spare if the big *jirgah* was to come off on the date arranged.

Three R.E. parties set forth, therefore, to examine the country on ahead—along the right bank, the left bank, and the river route itself. The last, it was reported, would require a fortnight's work to render it practicable for laden camels ; and it was ultimately decided that a track over the hills on the left bank, well inland from the river, promised the least heavy work of the three alternatives.

All next day the sappers, assisted by infantry working-parties, toiled on the construction of a camel road over those bleak, wind-swept hills ; and by nightfall a necessarily winding, but good, 8-ft. track curled its three-mile length to Narai Raghza. This plateau was up-stream of the Narai Tangi, the lower of the defiles described above ; so that had been circumvented, and a path made down to the river, whence the water supply for the force was drawn during its two days' halt there.

Whilst the road-making parties pushed on with the work ahead next day, the force moved up to Narai Raghza ; but the remaining four miles of track to Kundiwam proved somewhat more difficult than the three already done. In many places the alignment along the hillsides could not avoid rocky drops of seven or eight feet, which had to be ramped. Big rocks elsewhere had frequently to be blasted away ; for one has to consider the comfort of the laden camel closely, as he does not show to the best advantage on hilly ground ; and we had 1,700 of him to legislate for. Hence, dry stone retaining walls are required here to support the track ; and there frozen rivulets crossed must be specially treated to save our awkward carriers from slithering over their glassy surface with their padded feet and, peradventure, spread-eagling themselves so badly as to necessitate their destruction. Nevertheless, by the end of the second day's work from Narai Raghza, an excellent track, nowhere exceeding a slope of 9°, was completed to Kundiwam.

The entire force marched to that place the following day without mishap, though the camels alone, stretched out in single file along this mountain track, would have occupied nearly two-and-a-half times its length between Narai Raghza and Kundiwam. One felt a glow of satisfaction, therefore, when the last of the 1,700 was safely settled in for the night, and the two obstructive *tangis* had been outwitted.

Camp at Kundiwam was pitched on a low plateau on the left bank of the Shahur, now known as the Khaisera, at an altitude of about 5,500 ft. above sea-level. The village of Kundiwam faced the camp, on the right bank ; while that of Manzara, and several smaller ones, were visible farther up the valley. They differed somewhat from

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those in the vicinity of Makin, in that they were completely surrounded by high mud and stone walls, and furnished with a low tower at one corner.

It was now the coldest season of the year; and the thermometer frequently registered 16° and 18° of frost—more than sufficient to freeze ink solid in its bottles within the shelter of a tent. Yet, in the early mornings, when most of us were shivering in "coats—warm, British," before the sun made his welcome warmth felt, the regimental *bhisties* (water-carriers) would be seen proceeding to the ice-fringed river, bare as to their legs, and clad in flimsy cotton garments only—purely from choice—to fill their *mussaks*, then frozen as stiff as boards. And presently a string of them would be seen wending their way back with these cheerless weighty skin vessels slung over their shoulders, and reposing against the region of liver and kidney. It fairly made one gasp, and wonder how these devoted menials could escape the ravages of pneumonia—to which numbers of sepoys fell victims during the expedition. It takes much, though, to curb the zeal of the Indian *bhisti* for tending to the wants of the troops by fetching them water at all hours of the day for cooking and other purposes.

The home of many of the worst *budmashes* among the Mahsuds, and the centre whence the large body of men issued to attack the Delimitation Escort at Wana, Kundiwam was very appropriately selected as the place to which the *jirgah* of Mahsud *maliks* should be summoned to hear the terms of peace offered them. The great Council was held on January 21st, and the Mahsuds informed by General Lockhart that they were to pay a fine of 12,000 rupees, to surrender all horses and other animals, rifles and cash, captured by them at Wana. Further, they were to hand in 200 *jezails* and 50 breech-loading rifles. Mullah Powindah was to be expelled from the country; and the Mahsuds were to keep open the road recently constructed between Jandola and Kundiwam, as well as the one to Wana, on which we had already begun work.

Though the Martini rifles of those days were valued by Government at roughly 30 rupees, they would fetch eight to ten times that price among the tribes living across our border, where a breech-loader was valued by a Pathan at little less than his life. The few rifles of this description then to be found in Mahsud territory had probably been obtained at the risk of the lives of skilful trans-frontier rifle thieves in India. The surrender of fifty such, out of possibly 300 in the country, was thus no mean test of whether the Mahsuds had had enough of our presence in their midst. The *maliks* were given until March 1st to comply with the terms; and the force would remain in occupation pending compliance.

Meanwhile, the sappers pushed on with the new road from Kundi-

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wam to Wana, about thirteen miles distant through the hills to the south-west. Sir William and his staff left for Wana the day after the great *jirgah* was held, and Gen. Penn Symons assumed command at Kundiwam. As it was likely the Jandola brigade would be halted here for a month or more, the defences of the camp perimeter were much strengthened; and all proceeded to make themselves snug for the rest of the winter by constructing mud and stone fire-places as cheery adjuncts to the various mess and office tents. The chief drawback, however, was the scarcity of fuel for the troops, and grass for the animals, which necessitated parties going out long distances in order to collect a sufficient supply of these essentials.

In spite of occasional Waziri outbreaks near the L. of C. posts established between Jandola and Kundiwam, the Mahsuds as a whole seemed inclined to knuckle under, as a result of the privations they had suffered by the invasion of their secluded haunts. And here at Kundiwam they even went so far as to start trade by bringing in eggs and fowls for sale—needless to say at exorbitant prices—as well as grass and potatoes. The latter were fairly extensively cultivated in the neighbourhood, and formed a much appreciated addition to our frugal table. Within a few days of the *jirgah* also, several horses and rifles captured at Wana were brought into camp, and handed over to the Chief Political Officer, who retained his headquarters at Kundiwam.

The outlook was becoming so satisfactory that Gen. Symons now decided that efforts should be made to open out the river route between Kundiwam and Para Khel Kot. This would reduce by several miles the distance to be traversed by camel convoys required to ply between Kundiwam and Jandola, in order to maintain the force; and would greatly ease the strain on the camels by avoiding the hilly inland détour which had been constructed as an emergency measure to reach Kundiwam expeditiously. Owing to detachments, there was now only half a Company of Sappers with the Jandola brigade, but my C.O. and I had for some time past desired to try and make the two formidable *tangis* practicable for camel transport, so hailed the general's decision with glee.

The upper *tangi*, as previously stated, consisted of a chaotic mass of huge boulders and rocks in the bed of the stream, which was confined in this two-and-a-half miles of its course to a wild stony gorge. Along the broken slopes of the right bank, however, there ran a rough footpath, a mere goat-track in width, with numerous ups and downs but well above normal water-level. This, we believed, could be converted into a camel-road by much blasting, construction of retaining walls, and re-alignments to avoid unduly steep portions. Thus, work was started by the sappers, assisted by small infantry parties, on the 26th January.

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The Shahur Zam was subjected to a terrible bombardment during the next few days, such perhaps as it had not experienced since the dawn of creation. Dynamite and gun-cotton were not stinted, and the booms of loud explosions reverberated far and wide amid the hill-tops, while boulders flew into fragments, and sides of the gorge came thundering down. All seemed senseless and wilful destruction; yet, out of the débris, dry-stone walls steadily began to rise aloft. And, as day succeeded day, order emerged from confusion until, towards the close of the fifth day, behold a broad well-graded roadway hugging the hillside, along which one might have driven a gig throughout the entire length of two and a half miles to near the mouth of the lower *tangi*, the Narai, or "narrow tight place," in Pushtu interpretation.

Grateful as we had been for the assistance of infantry working-parties hitherto, we now decided that the sappers alone should tackle the tricky task on the Narai *tangi*. There was no avoiding the river bed in this last sixty yards of beetling defile; and the space was too limited, and the work somewhat too technical for infantry aid to be of much service. The first job was to clear the up—and down—stream approaches to the gloomy cañon of the great boulders which impeded entry; and these were blown to smithereens with dynamite as a preliminary to further operations.

We could now concentrate our attention on the jammed rock, two ends of which rested on either side of the chasm, the other two pointing upwards and downwards respectively. We estimated that this huge diamond-shaped obstruction weighed not one whit less than twenty tons; and this mass would have to be entirely disintegrated before the five-foot opening spanned by it near the base of those smooth-faced cliffs could be sufficiently widened to permit the passage of laden camels through the orifice. By means of a rough ladder, sappers were able to clamber on to the top of the rock, about twelve feet above the bed of the stream. Icy blasts hurtled through this sombre sunless slit in the mountains, and in their cold and confined position the men required frequent reliefs while they toiled, for the greater part of the day, drilling holes into the upper half of the rock.

Towards sundown the requisite number of holes were bored and filled with dynamite. The sappers were then sent out of the *tangi*; my C.O. and I took their place on the top of the rock, and adjusted detonators and fuses to the several charges. "Are you ready?" "Right." "Then, fire away."

We lit the fuses, and, when they were satisfactorily spitting out their jets of flame, we scrambled down from our precarious perch in next to no time. Reaching the bed of the stream, we seized the rickety ladder between us and carried it off with considerable celerity up the icy rivulet. A thirty-yard paddle lay before us ere we gained

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the mouth of the *tangi*, whence we hurried to join our men in the zone of safety without.

A few moments of eager anticipation followed, and then a terrific detonation smote the quiet of the fading day. It seemed to issue from the very heart of the mountain, and caused the earth to tremble beneath one. Allowing time for the smoke and dust within the cañon to dissipate, we mounted our ponies to view the result of the explosion. The top half of the rock had been completely cut away, as we had hoped, but the débris effectually blocked the narrow passage below save for a small opening through which the stream, formerly six inches deep but now banked up to a depth of two and a half feet, was pouring. Shades of night were falling, and we were an hour's march from camp, so we attempted nothing further then.

It was desperately cold work removing the débris next day, for much of the morning was spent standing in icy water nearly up to the knees; so pine log fires were kept burning at each end of the *tangi*, where relays could thaw themselves at intervals. The whole day were we employed in the gloomy gateway clearing the bed of the stream, and jumping fresh holes into the half of the rock that still remained suspended between the cliffs. This in its turn was duly pulverized during the course of the day, and all débris removed before nightfall.

We were now able to work on the face of the cliffs throughout the next two days by rigging up rough scaffolding of pine logs to support a few boards. Holes could conveniently be jumped from these into the solid limestone sides, which had become worn almost as smooth as glass by æons of flowing waters. Blast after blast was got off, and by the end of the first day's work on the cliffs the five-foot orifice had been widened to seven feet; and this was increased to eight feet when work ceased next evening.

Thereupon, the Narai Tangi was put to its first test as a highway the following morning. A large convoy of camels left Kundiwam by the river route for Jandola, and before noon the last camel had passed safely through the upper and lower *tangis;* but it was deemed advisable to remove yet a few more chunks of cliff at awkward corners in the sixty yards of twisting *tangi*. These were subsequently blown to dust, and the defile trimmed throughout its length to a minimum width of eight feet six inches, which proved ample for the requirements of the Field Force during the remainder of its sojourn in those inhospitable regions. The *tangis* had been conquered; but in spite of the cold and discomfort of working in that sombre rocky cleft, I think we one and all experienced a tinge of regret when this labour of interest and excitement came to a close.

Even on service in remote regions the British officer contrives to snatch an occasional day for relaxation; and towards the end of

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January a party of fifteen of us, accompanied by a small escort of Indian cavalry, set forth on a mounted trip to Wana and back. The distance was but thirteen miles there, and leaving Kundiwam at 10 a.m. we reached the Wana brigade camp in good time for lunch, thanks to the fine road through the hills recently made by the sappers. It was refreshing, after being for long surrounded by mountains and hills, to emerge again on to the open Wana plain. It is treeless, roughly 13 miles long by 11 wide, and situated at an altitude of about 4,500 ft. above sea-level. The brigade was camped near the site attacked by the Mahsuds in that grim hour before dawn in November; so there was much of interest in visiting the more important spots connected with that affair, and having events described by those who had been present at the fight. During our return journey we made several halts in the hills to shoot chikor, large numbers of which red-legged partridges were seen tearing about the stony slopes.

Now that we were settled down in a stationary camp, steps were taken to construct a miniature race-course on a comparatively flat *kach* just outside our perimeter. Although we could not run to a larger circuit than 550 yards, still we got up some very enjoyable gymkhanas, athletic sports for the men, and so forth; and even blossomed out into a Kundiwam First Spring Race Meeting towards the middle of February. This was restricted to local entries; but ten days later the Second Spring Race Meeting was held, and for this a contingent of officers arrived with their mounts from Wana, and spent the night with us. Our remaining half-company of sappers also rejoined from Wana the same day, after erecting numerous pillars during the recent delimitation work beyond that place.

Being once more re-united, the 5th Company, B.S. and Miners, received orders to march some six miles north up the Khaisera, with an escort of 38th Dogras, to construct a road from the eastern side of the Inzar Kotal down into the Ṣhakai Valley. A track up the western slopes from Wana had already been made by the 2nd Company when that brigade advanced to Kaniguram in December, and we were required to continue it on this side of the hills. We made a defensible camp near the village of Torwam, a few miles to the north of which lay the Sharwangi Kotal, the scene of an engagement with the Mahsúds during the campaign of 1881.

In order to start work from the Inzar Kotal next day, we had to tramp a distance of six miles from Torwam before we reached the point where the other Company's road-making ceased, the pass proving a very ill-defined one. Commencing from the far end, however, we completed one and a half miles of road over difficult ground before returning to camp; and next day added another similar length of heavy work homewards, in spite of our C.O. meeting with a most regrettable accident.

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At a certain corner it was found necessary to blast away four big rocks that impeded the path. When the holes had been prepared and the mines charged, we lit the fuses and retired to what we regarded as a safe distance, beyond an intervening spur. Following the explosion, a piece of rock weighing six or seven pounds was hurled close on a hundred yards. It topped the spur and struck our C.O. a violent blow on the point of the right hip-bone before he had time to see and dodge it. He was knocked completely off his feet, and lay on the ground in great pain, quite unable to move. Although a huge lump rose at once on the injured part, we hoped no bone had been broken, and sent three men off on mules to bring out a stretcher from camp, which was more than four miles distant. He was there carefully examined by a medical officer who came out from Kundiwam next day. To our relief he stated no bone was broken, but that if the blow had been dealt two inches lower the thigh would probably have been fractured.

Our C.O. had thus to be thankful for small mercies, and was removed to Kundiwam in a *dhooly;* and there he was confined to his camp-bed for the next ten days. Meanwhile, the work on the road continued, and two days sufficed to complete what remained of the six miles odd that constituted our task, when we, too, returned to Kundiwam.

By the end of February the Mahsuds had complied with all the terms imposed on them, and even asked the Chief Political Officer to try and arrange that the Indian Government should take over their country, and administer it for them! This request was not regarded seriously, however, by the then Lieut.-Governor of the Punjab; but one cannot now help thinking that, had this unsolicited opportunity been taken advantage of thirty years ago, much subsequent trouble, loss of valuable lives, and staggering expenses might have been avoided.

The ingrained perversity of these truculent mountaineers, who have frequently since kicked over the traces, might by now have been guided into saner channels, and some sort of law and order established in their midst. But only of late, after all this lapse of time, would it appear to be recognized that in the permanent occupation of part of their territory lies the sole solution of curtailing the activities of this restless tribe.

The month of March was ushered in by highly inclement weather, much rain falling; and on the 8th, the 5th Company, B.S. and Miners, was transferred to the Wana brigade, where we arrived to find that Gen. Turner had left with a column that morning for the Dana Valley, to the north-west, whither we were to follow him next morning. Heavy rain fell during the night, thus greatly increasing the weight of all tents for the mules when we started across the plain at

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9 a.m. Whilst traversing a low range of hills bordering it to the north, we obtained a magnificent view of the entire Wana plain stretching for a distance of 10 or 12 miles in a southerly direction to the hills, beyond which the Gomal river flowed east to join the Zhob. Four years before, I had been working with the first party of British officers who had ever visited the gorge of the Gomal thereabouts, on a strategic railway survey along its course. Wana, though known to us by name then, had not been entered by Indian troops, and the plain was hidden from our sight by the confused mass of rugged hills through which the Toi, draining the Wana plain, threaded its way to join the Gomal at Toi Khula.

The view conjured up visions of a miserable Christmas Day spent in the Gomal near the junction of the two streams, where we were trounced by a piercing gale straight from the snows, accompanied by fierce squalls of rain. And, indeed, our present plight was little better, for throughout the whole march, rain continued to fall intermittently; and, as we gradually ascended to higher altitudes, it became exceedingly cold as well. During the last three miles of our fourteen-mile tramp, we passed numbers of small hamlets with their inevitable tower; but conditions remained distinctly depressing, and we were relieved to catch a glimpse of Gen. Turner's camp shortly before 2.30 p.m. Luckily for us the column had not marched that day, owing to the steady rain and threatening outlook at dawn.

The camp was pitched on a very rough restricted plot of ground at a point where the Dana valley contracted considerably. Dana village itself was perched on a knoll about a quarter-of-a-mile downstream; and as we were more than 1,000 ft. above Wana the spot proved a cheerless one, for sleet and snow fell ceaselessly all that afternoon and night. We were to have marched nine or ten miles farther up the valley, despite the weather next morning, but the general received an urgent message from Force Headquarters, then in the Tochi, to despatch two Gurkha battalions of his brigade to Tank at once. He therefore returned to Wana with detachments of these two battalions that formed part of the column; and the remainder of the column followed next day, after being able to accomplish little in the way of reconnaissance or road-making on account of the incessant rain, sleet and snow.

Stirring events were evidently afoot elsewhere; for, when we reached Wana, the Gurkha battalions had already left for Kundiwam, in order to join the remnants of the Jandola brigade starting for Tank, and the 38th Dogras arrived from Kundiwam to take their place in the Wana brigade. We now learnt that serious trouble had broken out in Chitral, where Umra Khan of Jhandoul was in rebellion against the local princeling. Thus a fresh expedition was being rapidly organized to deal with the threatening situation which had

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arisen in that region of our far-flung frontier. But the 5th Company B.S. and Miners, alas, was to remain attached to the Wana Brigade. And so we embarked on further road-making, and other useful works, in the neighbourhood.

At the end of March I received orders to join the 2nd Company, then with the Tochi Valley Field Force; and accordingly left for Bannu on April 1st, with a convoy bound for Kajuri Kach to bring up more supplies to Wana. Travelling along the seven miles of road we had recently made to Karb Kot, we there swung away from the Toi stream and continued to the Katina camping-ground, another seven miles on. A further march of twelve miles next day over plains and through low hills, now bright with spring flowers, such as tulips and crocuses, landed us at the new Kajuri Kach Post on the right bank of the Zhob—at its junction with the Gomal.

Four years before, nothing had been located there save a miserable little Waziri Levy post, the wild occupants of which were supposed to afford protection to travellers spending the night without the shelter of its walls. Actually, they were not above participating in raids on those camped outside, if such happened to be Sulaiman Khels, or of some other enemy tribe. These sparkling *jeux d'esprit* were now, however, a thing of the past, for an imposing fort had taken the place of the levy post, and was garrisoned by three companies of Indian infantry and a troop of Indian cavalry. Within its precincts were a large commissariat establishment, transport lines, a post and telegraph office, and at least three British officers always in residence. In short, all the comforts of a home obtruded themselves at this outpost of Empire.

Below their junction, the combined streams of Zhob and Gomal enter a formidable series of rocky defiles known as "Browne's Gorge," after the late General Sir James Browne, a noted frontier officer, who was the first European to view them. Through these awesome cañons no passage for man or beast exists; so the traveller at once strikes away from the river on leaving the Kajuri Kach post, and clambers to the summit of the Gwaleri Pass. Thence, threading his way 'mid a network of hills, he descends gradually to the banks of the Gomal below the gorges at Nilai Kach, distant about sixteen miles from Kajuri Kach. Accommodation is there provided in a dâk bungalow within a fort, constructed at the junction of a large nullah with the Gomal. On the top of a bluff of surprisingly variegated colours is perched another post, held by a company of Indian infantry; whereas the lower one affords shelter for Waziri levies employed on escort duty to Jatta, the next stage towards the plains of India. Between Kajuri Kach and Nilai Kach this duty devolved on regular troops.

Shortly after leaving Kajuri Kach at 7 a.m. we met the advanced

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portion of a multitude of Powindahs, bound for their homes in Afghanistan now that the approaching hot weather in India had put an end to their trading activities in that country. Soon we were in their very midst; and during the greater part of the day's stage we floundered through this host, who carried their cherished goods and chattels on immense droves of camels, and even diminutive donkeys loaded to the gunwale. Men, women and children were all agog urging forward their slow-moving beasts of burden, and flocks of sheep and goats, along the narrow roadway. This was in many places cut deep into the steep hillsides, and here the passing of the cavalcade was frequently a matter of delicate calculation to avoid a plunge on horse-back down forbidding slopes. We, too, were accompanied by camels and mules, thrusting in the opposite direction, so progress at times was laboured. Particularly was this the case near the summit of the Gwaleri Pass, where the greatest congestion occurred, and where the serpentine track was much intersected by numerous small *nullahs* which made it difficult for the contrary currents to cross without mishap.

I had often previously seen caravans proceeding up and down the Khyber, to and from Central Asia, but there was an air of novelty about this Powindah migration which made it far more attractive in my eyes. The men were fine specimens of humanity with frank open faces, and were mostly armed with swords and daggers, though a few carried rifles. The youngsters were the jolliest set of rogues I had ever seen out East, laughing and shouting in the highest of spirits, and evidently in enjoyment of the most robust health by reason of their rough outdoor existence. Many of them were very fair, and not a few had quite light hair and blue eyes. The young women, too, were often really pretty; and one damsel observed would have reigned as a beauty anywhere. She seemed to be about eighteen years of age, was unusually fair of complexion, and gazed on the turmoil around through large blue eyes. Her smiling countenance displayed a perfect set of snowy teeth, which enhanced the Madonna regularity of her features; whilst a fringe, cut straight across the forehead, peeped out from below the dark blue cloth thrown over her head. Her practical woman's garment of pyjama trousers fitting tightly about the ankles, and surmounted by a loose dark blue gown falling to little above the knees, completed her picturesque appearance. The beauty of these females soon fades, however, owing to their hard life on the road and at home; and by the time a woman reaches thirty she usually looks old and wrinkled, though still full of work.

That the life of these wanderers is a hard one a few words will make clear. The term Powindah is applied to the great warrior traders of Afghanistan, who yearly bring down goods from distant

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Bokhara and Afghanistan for sale in the Indian markets. They belong, in the main, to the important Ghilazi tribe, whose chief town is Ghazni, between Kandahar and Kabul. At the beginning of each cold weather these people collect their families, thousands of camels, sheep, goats, etc., to the east of Ghazni, and set out for India with their goods. They march in regular armies, and are well organized, in order to resist attack by hostile tribes—more especially the Waziris about the Gomal, who for generations have carried on war to the knife with these hardy traders. On reaching Tank their arms are deposited under the charge of the Indian Government ; and whilst many of the men penetrate to all parts of India with their goods, their families remain in the neighbourhood of Tank, where ample grazing grounds exist for their numerous camels and flocks, under the protection of perhaps two-thirds of the fighting men. The approach of the hot weather recalls the itinerant traders to Tank, with goods purchased in India after selling what they had brought from Central Asia. Their arms are now handed back to them, and when the multitude is once again assembled the homeward march to Ghazni begins.

But their travels do not cease there. The women and children are again left behind, as at Tank, while the men continue into Central Asia to trade in the goods brought from India, for which they find a ready market in the bazaars of Turkestan and other remote parts. Still, they are always back at their homes in time for the annual migration to India as soon as the cold season sets in. Thus the men are ever on the move, and their organization, with all this wealth of experience behind them, reaches a high pitch of excellence for Orientals. The rapidity with which their animals are loaded up in the mornings, and the absence of confusion on the line of march is remarkable. Every man has something to do, and does it. Likewise, every woman, boy and girl has some allotted task ; and though all appears babel and bustle, there is method in the din, and the show works smoothly.

It is estimated that about 50,000 of these nomads enter the Dera Ismail Khan district every year by the Gomal route between the middle of October and the middle of December ; and return between the 20th March and 10th May. The advent of these warlike traders, at the time of which I write, was no small boon to the Indian Government if some frontier expedition was about to be undertaken ; for these men willingly hired out their camels for transport purposes, and accompanied them in the field. It is probably no exaggeration to say that three-quarters of the camels employed on this particular Waziristan Expedition, amounting to several thousand in all, were the property of Powindahs.

In the twelve-mile stage from Nilai Kach to Jatta the road ran

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at first along a plateau on the right bank of the Gomal. The left bank was here bounded by a mass of low pinnacle-shaped hills, beautiful in their kaleidoscope of colour, and much furrowed and fluted by the torrential downpours to which they are at times subjected. These became gradually replaced, however, by magnificent vertical cliffs of austere conglomerate on both banks, and between them the road wound its sinuous course for some distance. Four or five miles short of Jatta we crossed the now comparatively narrow Gomal by a wooden pile bridge. Continuing our way through the low out-lying hills of Waziristan, we soon emerged on to the plains of India and reached the Murtaza post. In the remaining three miles to Jatta we followed a broad open road leading through green fields of tall wheat; and as the trees were also bursting forth into their fresh young leaves, the scene was a striking and smiling change from the barren wastes of Waziristan, to which we had grown accustomed during the past four months.

At Jatta post, too, accommodation for the British officer travelling on duty was provided in a dâk bungalow; and thence an easy ride of fifteen miles over level plain, and along a veritable Queen's Highway, landed us next day at the relatively important post at Tank. Here we were once more on familiar ground, and as the mail tonga plied the forty miles between Tank and Dera Ismail Khan, this part of the journey was covered comfortably in less than six hours the following day.

Thus the winter sojourn amongst the Mahsuds was brought to a close on April 7th. In order to reach the Tochi Valley, however, a further tonga journey of ninety miles northwards along the fine frontier road to Bannu had to be undertaken on the 8th. And in the Tochi, near by, but only entered shortly before by British troops for the first time, it was my lot to pass another fourteen strenuous months with the Field Force.

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THE FUTURE OF MILITARY ENGINEERING.

By COLONEL J. F. C. FULLER

THERE have always been two forms of war—sieges and field battles. At times the one has preponderated, and at times the other, but until the introduction of cannon the capture of fortresses and fortified cities was one of the most difficult and costly operations of war. Once the cannon challenged the stone wall the gunner took over much of the sapper's work, and the sapper from a siege specialist became an assistant to all the arms and services in the army, whether its object was to carry out a siege, fight a battle, or undertake a march.

To assist is to do what others cannot do, or if they attempt to do it will detract from their own particular work and duties; further, to do something which is essential to the economy and the smooth running of the army as a whole. For example, an army may be compared to a clock. In a clock each wheel, lever and spring does something, which each other wheel, lever or spring, cannot do; and the more perfectly each individual part performs its work, according to the plan upon which the clock is designed, the more perfectly will time be registered. The difficulty to-day is that no one as yet has settled on the design of our military clock, and until this design is fixed no single part can clearly see its object and economically carry out its work. This should not, however, be made an excuse to do nothing, for otherwise, when the time comes to effect a change, mentally we shall be unprepared.

THE PURPOSES OF THE ENGINEER.

In order to see clearly, freedom of thought is essential. All interests and prejudices must be set aside, and basic principles must be laid bare, examined and applied. To understand in what way engineers can economically assist the other arms to-day, and how far the method of this assistance must be kept elastic, so that it may change as the other arms change, a good deal can be learnt from past history. It is by looking backwards and by discovering the reasons for success and failure that we best teach ourselves how to prepare for the future.

In quite early times the fighting troops themselves were their own engineers, but as armies became more organized, and walled cities more numerous, it was found necessary to train a special body of

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men to work the catapults, battering rams and other siege engines. The word engine (Greek Organon and Latin Organum) gave them their name. They did not construct defended camps or dig trenches, for these duties were performed by the fighting troops, they were essentially constructors, maintainers and workers of engines.

In the French Army, at a very early date, we find "Ingénieurs," and in our own army we find that William the Conqueror had an officer called "Ingeniator." Later on, when cannon came into use, we find that it is the engineer who is placed in charge of this new "engine," the "Ingeniator" becoming the "Attillator," from whom is descended the present Master General of the Ordnance.

In Henry VIII.'s reign the Chief Engineer was one William Pawne, who, having fallen out with Cardinal Wolsey over certain fortifications at Tournay, wrote to him as follows: "Not daring to be tedious remembering your Eminence's manifold services. I am not fumous as report has been made. My fumes never hurt any man so much as myself;" which clearly tells us that his main business was connected with artillery.

The general adoption of artillery led to a rapid development of fortifications, and the result was that the engineer concentrated more and more on the building of fortresses, and in the carrying out of siege operations, the artillery becoming a separate arm. In France, under Marshal Vauban, the "ingénieurs" change their name and become known as the "génie," and in this change there is more than meets the eye. "Génie" is not derived from "engine," but from the Greek "geno" or "geneo," which means to procreate, a word allied to the Latin "genius"—a supernatural guardian spirit which attends the birth of every child. From simple workers of machines they, in their own estimation, had grown into a vastly superior class of soldier. Guibert, writing in 1773, says of them: "The Engineers do not know how troops manœuvre, nor how they are commanded. They do not even want to know these things, for they look upon their art as the first of all arts." In fact they had, in their own eyes, become a military mystery—a guardian spirit which presided over the birth and destiny of the common soldier.

THE FOUR GUIDING FACTORS.

To turn now to the present problem. To co-operate with the other arms is to do something which is essential, and yet which cannot be done efficiently or economically by these arms themselves. The first problem of the engineer is to know accurately and in detail what the troops can and cannot do, and until this problem is solved there can be no economy of work. The second problem is to foresee what the troops will be able and will not be able to do in the future, and until this problem is solved there can be no certain direction of progress,

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These two problems solved, the path is made easy, for then all that remains to be done is for the engineer to examine what he is now doing, and if necessary to amend it.

In solving these problems there are certain factors which I think can assist us, and which throughout history have been common to all types of troops. These are as follows: All soldiers require information, protection, offensive power and power to move.

To-day the troops can reconnoitre, but they cannot make maps; they can dig their own trenches, but they cannot construct elaborate fortifications; they can assault a position, but they cannot mine it; they can swim a river, but generally they cannot bridge it. These are only four examples, important ones though they be, out of a host, but I think they illustrate the point I am driving at, namely, that true co-operation is based on economy of force, which demands a *proper* distribution of work.

The Changes which face us.

The second problem is not so easy, but it must be solved, if only provisionally. Unlike the first, we cannot see things, and consequently have in place to imagine them. We know, however, two things, namely, that the next war will be unlike the last, and that the four factors I have mentioned remain constant.

Our present means of waging war are slowly changing, but there can be no doubt that a change is taking place, and further that if a great war broke out to-morrow, either in Europe or in Asia, these changes would develop with amazing rapidity.

In brief, the main change is towards mechanization, which is mainly a problem of movement. It is not one of replacing men by machines, but of moving men in machines, far more rapidly than they can move by means of leg-power. To-day in military organization we are faced by the same problem which faced industry on the introduction of steam-power, and which faced road transport on the introduction of petrol-power. In the middle of the last century, willy-nilly, the Navy had to change from sails to boilers. At first many sailors were against this change, but it was inevitable, because steam-power could establish a greater economy of force. To-day in the Army the general introduction of the internal-combustion engine is equally inevitable and for an identical reason.

As steam-power changed sea strategy and tactics (in fact it changed naval tactics out of all recognition), so will petrol-power change land strategy and tactics. If comparison and inference are any guide, then the land battles of the future are likely to be as different from those of the last war as the Battle of Jutland differed from the Battle of Navarino.

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STRATEGICAL AND TACTICAL CHANGES.

To-day, we are confronted by many new means of waging war, such as armoured cars, tanks, aeroplanes and gas, which must, and will, radically change our existing conceptions of strategy and tactics.

To-day, land strategy is almost entirely woven on roads and railways, but cross-country machines, though they will not abolish roads and railways, will give to strategy another dimension. Armies will be able to move as organized units where they never moved as such before, and this increase in strategical power will radically change present-day tactics. Heretofore, great battles have generally been fought in the close vicinity of strategical avenues of approach; so much so has this been the case that it was often possible to predict where they would take place. But if these lines of approach widen in all directions, battles may take place anywhere in an extended and extensive area. The old conception of fronts may vanish altogether, fronts may be anywhere.

The type of war which faces us will be very different from the types which have faced us, because our means of fighting are changing, consequently, if the fighting troops are to pull their full weight, the engineering services of the Army must keep pace with these changes.

I will now attempt to outline what some of these changes are likely to be, and I will make use of the four factors I have mentioned, and will consider these changes from two points of view, namely, how the engineer of the future can directly assist his own side, and how he can resist enemy action.

THE PROBLEM OF INFORMATION.

The means whereby the engineer can supply information to the Army must remain surveying and map-making. Mapping has now been reduced to so fine an art that on first thoughts it may seem there is little room for improvement. This would be a correct deduction if the armies of the future were to be similarly organized to those of to-day. But this is not going to be the case, consequently what I will call "roadless" strategy and "area" tactics will demand a different type of map. To know where roads, railways and rivers run, where cities, villages, mountains and forests are situated will not be enough. All these common geographical features will be useful, but besides them must be added a host of strategical, tactical and administrative "features." For example, ground will have to be coloured to show where tanks and roadless vehicles can move at ease, can move with difficulty, and cannot move at all, so that at a glance a commander is able to see from his map how best to deploy his mechanized arms. Possible aerodromes, as well as existing ones, will also have to be marked down, as well as the direction of prevailing winds at various periods of the year; this latter information will be import-

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ant should gas be employed. Petrol supply and petrol stations, repair centres, motor works, machine shops, etc., should also be shown by conventional signs, for in a rapid mechanized war these will be as important as the marking down of wells, water holes and oases in desert warfare.

In brief, the surveyor and map-maker must more and more turn from purely civil map requirements to future strategical, tactical and administrative military requirements, on the accurate knowledge of which the movement and supply of armies will depend. Here is opened up to us a completely new theory of military cartography, and its development is essentially one of the duties of the engineer. The side which possesses the best maps will strategically move the quicker, and tactically commit fewer blunders. Consequently, the better these maps are, the more will the engineer be able to assist the Army, and to the detriment of the enemy, should he be less well provided.

The Problem of Protection.

I will now turn to the problem of protection, which is an immense one, since the protection the engineer afforded in the past will, in my opinion, have to undergo a radical change. To-day, much of his protective duties fall under the headings of fortifications, demolitions and fieldworks. The first are normally used to block roads and railways, the second to delay, or prevent movement, and the third to protect the infantry and artillery arms.

Though in the future permanent fortifications will continue, since roads and railways will still possess great use, it must be remembered that, when armies can move across country, the circumvention of fortresses will be far easier than it has been in the past. In 1914, the capture of Liége was essential to German success, for though it was possible to pass infantry round the fortress, it was not possible to supply this infantry until Liége was captured, since its chain of forts blocked the main road and rail communications.

Besides permanently fortifying centres of communication, other centres will also have to be protected. A mechanized army will require what I will call "land-ports," into which it can retire and refit. On what plan should they be built? Will it be necessary to protect them against the heaviest types of guns? Will a rapidly moving invader be able to equip his army with such weapons without serious detriment to his mobility? Will not gas attack be a better weapon than gun-fire, and will not gas attack come from the air? Here are a host of questions which must be answered before efficient land-ports can be constructed.

I do not propose to answer these questions, for their answers will take years of careful thought. In brief I feel that their correct answers will be very different to existing problems of fortifications.

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The present immensely strong concrete works, I imagine, will be replaced by a large number of weaker gas-proof strong points which will be so distributed over areas suitable for cross-country movement, that the greatest strategical, tactical and administrative use may be made of these areas.

Besides the defence of land-ports and centres of communication, aerodromes and industrial cities will have to be defended. A mechanized army will depend not so much on supply of man-power as on the industrial power of its country. The protection of industrial towns and areas will demand, therefore, as much attention in the future as the protection of communications has in the past. Here again are presented to us a host of complex and difficult problems in engineering.

The present theory of demolitions is to destroy. When, in 1915, the Russians retired from before the Germans, and when, in 1917, the Germans on the Western Front retired to the Hindenburg lines, the country abandoned was converted into a desert. In the future it may be sometimes necessary to do this, but the use of persistent chemicals will enable whole cities and areas to be rendered uninhabitable and uncrossable for days if not weeks at a time, without destroying anything. Such inundations should, I think, be the work of the engineers, and engineers must be equally capable of rapidly clearing inundated ground so that our own troops can cross it.

A point which should be considered is the relationship between new means of mobility and our present theory of demolitions. For example, the existing idea may be illustrated as follows: If Belgium were to prepare the area east of Liége for demolition, should the Germans once again attempt to occupy the Liége gap, will these demolitions prevent them from doing so? Is such a protective scheme feasible in the future? I do not think it is, because no country will demolish its own property until the last moment, and when faced by a mechanized adversary who can move at extreme rapidity the chances are that, unless demolitions are carried out before war is declared, there will not be time to do this work once it has been, and any partial destruction is unlikely to be an impediment to cross-country machines.

Demolitions of this nature will, I think, be replaced by gas inundations, and an elaborate protection of river lines, by anti-tank defences, and by land and water minefields; for there is every probability in the future of certain types of tanks being able to cross water. Here again are a number of new and interesting problems.

I will now turn to the third point I mentioned, namely, field defences. To-day, our theory of field defences is mainly based on leg-power—on infantry and gun tactics. Infantry and guns fight in lines, they have definitely a front, two flanks and a rear, and the front,

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as long as it remains intact or unturned, protects the rear. In the future, as I have pointed out, fronts may be anywhere, therefore field defences may be required anywhere. It cannot be expected that an army will be able to grid a whole area with trenches. In mechanical warfare time will be totally insufficient for this; besides, tanks can cross all but very wide trenches, and aircraft can fly over them. Some new system must therefore be devised.

Our present theory of field defences is based on the static theory of digging; in future this theory must be rendered mobile. There will be little or no time to dig, for fronts may be anywhere. The solution of this problem lies, I think, in the land-mine. In the past, wire entanglements have restricted the mobility of infantry, in the future, the land-mine may well restrict the mobility of the tank. Arrangements will have to be worked out which will enable the engineer rapidly to lay mines, take them up, and move them from front to front. In this lies a whole new theory of field fortification. Will these mines be laid in lines or set out in groups? I think the group system will prevail. In place of the block-houses we made such use of in the South African War, will be established anti-tank strong points—guns protected by a "wall" or "moat" of mines, and between them will be held in readiness our mechanized counter-attacking forces.

Problems of Offensive Power.

The offensive powers of the engineer are obviously closely connected with his protective powers. In the past, his main offensive duties have been: to carry out siege work, to lead the assault of a fortress, and to carry out mining. These duties will still hold good, but in changed forms.

Lines of circumvallation, and all the elaborate earth works and underground mining of the past are, I think, things of the past; in any case they are likely to form the exception and not the rule. Heavy artillery may still be used, but that its object will be to pound to pieces great concrete works is in my mind doubtful. The true tactical object in a siege is to protect or destroy *the garrison*, and not necessarily the fortifications. It would appear, therefore, that gas attack will often replace high-explosive attack, and mining will rarely be necessary, but that minefields, to restrict sorties from a besieged fortress, will frequently be used.

In besieging a fortified industrial centre, the true object is surely to capture it *with the least possible destruction*, so that when it is occupied use may be made of its resources and machinery.

In the sieges of the future is opened up to us an all but entirely new problem, based on the theory of gaining something which will be of

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use to ourselves, and not on that of merely denying its use to the enemy. Here is a multitude of problems for the engineer to think out.

PROBLEMS OF MOVEMENT.

At the beginning of this paper I stated that mechanization is mainly a problem of movement. Consequently anything which the Royal Engineer can do to facilitate the movement of the other arms, and restrict the power of movement of the enemy, is of the utmost importance. In the past, railway construction, road making and repair, and the building of bridges, have been essentially the work of the engineers, and they will remain so. Whilst railways and roads will become less important, bridges will become more important, for, except for mountains, water obstacles are the most formidable which confront a mechanized army.

The rapid clearance of ground for aircraft landing is another problem of mobility, and there are many others of a similar nature which I must leave to the reader to think out for himself. There is, however, one problem, and probably the most important one of all, which I will now examine, namely, the problem of repair.

A mechanical army is one which must depend for its mobility on the efficiency of its machines. Efficiency demands maintenance and repair. Maintenance is the duty of the fighting troops, but repair is beyond their powers.

Before the war the question of repair was comparatively a simple one. The medical service repaired the men; the veterinary service the horses; the transport service the vehicles, and the ordnance service the weapons. Mechanization is now influencing all arms, for all types of soldiers are beginning to be transported. It seems to me, therefore, that in the near future we shall have to establish a Corps of men whose duty it is to repair the "new engines," and I am of opinion that the Royal Engineers are the Corps which should do this work. We do not want new Corps, we have already got too many, and every additional one introduces complication. What we now want to think out is the redistribution of work, and it appears to me that the work of repairing machines is essentially the duty of the engineer. In any case this suggestion brings us back to the original idea of the engineer, namely, a man who deals with engines, and not necessarily with the spade, or with the mason's trowel.

I do not intend to elaborate this suggestion, as I am far from certain in my own mind how it can most effectively be carried out, but I cannot help feeling that it is a sound one; consequently, that the main duties of the Royal Engineers in the future will be divided into three categories, namely—(i) survey, (ii) tactical protective and offensive assistance to the other arms, and (iii) the repair of warlike machines other than actual weapons, such as guns, rifles, etc.

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Conclusion.

I have now placed before the reader a certain number of ideas; some may be sound and others the reverse, but, so I think, all are worthy of examination because the Army is to-day entering a period of transition. Mechanized warfare faces us, whether we like it or not, and as certainly as it faced horse transport from the opening of the present century until this day. Mechanized warfare means rapid movement in all directions over a plain and unbroken surface, and it must be obvious to all that if we can restrict our enemy's power to move, as well as enhance our own, the advantage will be ours. To do so we must discover and develop a new system of fortifications, and unless we do so others will, for as night follows day so do static periods follow mobile periods in tactics. In fact, the one begets the other of necessity. If this contention is accepted—and I fail to see how it can be refuted—the military engineer is faced by a host of new and difficult problems, on the solution of which will depend the economical use of mobility itself.

To examine these problems thoroughly two categories of knowledge are required—sound general knowledge, and accurate special knowledge. No man can possibly be efficient as an engineer unless he knows all about engineering, as well as a good deal about the work of the other arms. Assistance does not lie in doing other people's work, but in doing something which will enable others to do their own particular work more perfectly.

There is no mystery about engineering, save to those who are ignorant of what it entails, and assistance to the other arms is not to be sought in encouraging fools. If Sappers make their work a mystery, they will only encourage others to become mysterious out of self-preservation, and eventually the army will become a box of tricks—as it is, I am afraid, very much so to-day. And the result in war will be that we shall surprise ourselves in place of surprising the enemy.

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HEAVY EARTHWORK, USING DIGGERS OR STEAM NAVVIES.

By MAJOR I. SIMSON, R.E.

INTRODUCTION.

(1) The art of earthwork, better known to officer, N.C.O. and man as "muck shifting," is one that sooner or later has usually and in varying degree to be undertaken by the R.E. officer on active service. In peace time, whenever any large excavation is required the contract is usually placed outside to a civilian firm well versed in the art of removing a mountain and depositing it elsewhere in another shape. In these circumstances for the R.E. officer the question becomes mainly one of finance in peace time, or of watching and hurrying up the contractor to see that various stages of the work are completed to schedule time. The contractor as a rule has to worry out his own salvation, with the result that the R.E. officer, not being directly responsible for solving the many organization, technical and transport problems that arise, seldom gets really first-hand experience of this subject. In many cases this experience may have to be bought later on active service, while the army perhaps waits for the completion of a railway or road longer than it otherwise need.

RELATIVE IMPORTANCE OF EARTHWORK IN WORKS.

(2) The following figures for labour only on railways are illuminating as to the relative importance of earthwork, and show the percentage of the total job for railway construction in *average country*. In difficult country the importance of earthwork (and bridges) rises enormously. The Table shows also the reduction in earthwork and bridging in war, as compared to peace.

Detail. (4′ 8½″ gauge railways.)	Railway construction by British Troops in France, 1914/18	Railway construction in peace time in America before 1914.
	Based on time. (Men-days.)	Based on cost. (Dollars.)
	Labour only.	
1. Survey and drawing office ...	About 5%	5% to 10%
2. Earthwork and culverts ...	40% to 60%	55% to 65%
3. Bridges	About 10%	About 15%
4. Linking	15% to 20%	5% to 15%
5. Ballasting, lifting, packing ...	15% to 20%	5% to 15%
Total	100%	100%

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Corresponding figures for road construction are not known to the writer, but such figures would probably show that earthwork is again the predominating factor.

(3) The above figures clearly show that, whereas speed in minor bridging or linking (*i.e.*, actual laying of rails and sleepers) may save days on railway construction, and can easily be seen and appreciated by the "average man," real care and attention to detail on earthwork may save weeks—and yet the saving is by no means so obvious to the "average man" or even to many a trained engineer. Confirmation can be had in peace time by the fact that the most successful civil engineering firms are those that are able to deal expeditiously with large volumes of earth, as in the construction of dry docks, railways or arterial roads. Moreover, contracts for the earthwork portion of such works are now frequently sublet to firms who make a speciality of this work and do nothing else.

(4) It may be noted here also that the above Table brings out another very important point, viz., that,as one of the primary objects of survey is to reduce earthwork, a very little extra time in men-days spent on a full and proper survey and examination of a project reaps a really golden harvest in cutting down earthwork time later. Although this fact is generally realized, it is frequently overlooked in the hurry-scurry of active service, when working parties are sometimes thrown a little prematurely at the head of the R.E. officer.

Definition.

(5) All earthwork can be divided into three subheads :—

(*a*) "Getting," *i.e.*, digging and loading into some kind of vehicle ready for transport, *e.g.*, a basket, wheelbarrow, G.S. wagon, railway wagon, etc.

(*b*) "Carrying," *i.e.*, transporting it to the site ready for off-loading. The "carry" varies from a few feet for a single throw from a shovel, to several miles which is common in railway or arterial road work.

(*c*) "Off-loading" to waste or to form an embankment, station platform, etc.

In this note, "heavy" earthwork is understood to mean the process of "getting" earth by means of machinery to supplant the large numbers of men, otherwise necessary to obtain the same output. The machinery employed consists of drag-line excavators, grabs, and diggers or navvies. Of these the machine most likely to be employed on active service is the "digger" for road and railway work through hilly country. The following remarks are based entirely on the digger,

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but apply to other machines also in principle. Carrying and off-loading are not considered except in so far as they have an effect on "getting."

DIGGERS.

(6) Diggers are now on the market ranging from about a ¾-yard bucket (or even smaller) up to a 4-yard bucket. The former is a No. 6 size machine, the latter a No. 30 machine, this number representing the bale pull in tons. If mounted on rails the corresponding *working* gauge varies from about 6½ feet to 12 feet. When mounted on rails and driven by steam or oil-engines, these machines weigh from 17 to 120 tons respectively. For active service, machines on rails are unsuitable owing to the continuous delay in laying, slewing, and pulling up track built with heavy rails and long crossing timbers. If mounted on road wheels, similar objections exist because a roadway of sleepers or timbers is essential. The same-size machine, mounted on caterpillar tracks is slightly heavier, but far more mobile and adaptable, and the majority of makers now fit such tracks. For stability the gauge of all three types is roughly the same. Caterpillar tracks enable the machine to move short distances from job to job without dismantling or building a special railway track or roadway; and at once cut out the large number of men otherwise essential for digger track construction and maintenance, which is a heavy and continuous item. For service purposes caterpillar tracks are ideal and, in fact, essential.

With regard to stability, when on the move, most machines are capable of travelling up or down or at right angles to gradients of about 1 in 6. This limiting gradient can always be obtained from the makers. When digging, if the bucket teeth strike an obstruction, the engine is usually designed to stall before the machine pulls itself over.

OUTPUT OF DIGGERS.

(7) Assuming no serious delays for trucks, coal or water and in easy soil, the capacity of a digger in charge of a good driver is really remarkable; and on this basis a No. 6 digger (¾-yard bucket), manned by one shift of 4 men in all, can comfortably load about 400 cub. yards in 8 hours, working in a 5 ft. deep trench, 22 ft. wide. A No. 20 digger (2¾-yard bucket) on railway track in France was once loading between 2,000 and 2,500 tons of mine-earth or ballast (*terre de fosse*) from a 30 ft. face, during 9 hours of darkness, with screened lights and occasional interruption from enemy shelling. All such figures are, however, valueless without detailed conditions being known, the limiting factors being, in practice, seldom the digger itself, but the supply of wagons, coal and water. Big output depends literally and entirely on a solution of these three problems.

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Man-Power Equivalents and Principles of Operation.

(8) The best size of all-round machine for excavating railway or road cuttings on service is probably a No. 6 or No. 10 digger on caterpillars. Any larger machine will seldom attain a larger output under the conditions involved in driving railway or road cuttings, because of the difficulties of wagon supply. It will be seen that a No. 20 digger (2¾-yard bucket) as regards output can be considered the equivalent of, say, 300 tireless men working *at one point*. This congestion increases the difficulty of truck supply. A proper appreciation of man-power equivalent of the machine is essential by all officers, N.C.O.s *and men* concerned because the basic principle of any heavy earthwork job is to keep the digger itself working hard and continuously at all costs. To get maximum output, practically everything wants subordinating to the digger, as regards the supply of locomotives and trucks, water and fuel, and the operating and off-loading arrangements elsewhere. Further down the line the loss of time is obvious if, say, 60 men are kept waiting 20 minutes because the train they are to off-load is late. But it is seldom realized that this loss is less serious than the digger being delayed five minutes by possibly one dilatory man, such as a shunter. Moreover, the 60 men can usually be switched on to other work temporarily, whereas the digger can do nothing without trucks to fill.

On this basic principle of keeping the digger at work continuously, the lay-out of the "getting" end and the whole organization for getting, carrying, and off-loading must be built up so that every link in this chain is as strong as the first link—the digger—in order to reach and *maintain* maximum output.

Deep-Cut Method of Cutting.

(9) There are two main methods of driving a road or railway cutting:—(*a*) the deep-cut method, (*b*) the layer method. In the former the digger works through at the final formation level and grade, filling trucks *behind* it, and these trucks can only be hauled out *to the rear* to make up banks. The system is illustrated in Fig. 3. It is clear that trucks cannot easily be sent forward to make up embankments in front of where the digger is working. For service purposes this method will thus seldom be used. The digger, moreover, usually requires following up with three tracks. After two trucks on each outer track have been filled, shunting must be done because the digger cannot reach the third truck. The centre track is usually kept for coal and water wagons and for shunting. A serious disadvantage is that all three tracks require extension by special short rails every few hours, so that track-laying is continuous, and the length of shunt increases as the digger eats into the hillside away from the turnouts. In shallow cuttings the addition of track is continuous, and it may be difficult to keep up with the advancing digger.

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Layer Method of Cutting.

(10) The layer method is usually of greater adaptability for active service. It consists essentially in driving a series of shallow cuttings through the hill until the full depth is finally reached. These shallow cuttings *run parallel to the final formation grade*; and their depth and width depends on the digger and rolling stock dimensions. The digger loads into trucks on a track running the full length of the cutting site and *above* the level at which the digger is working. This track is temporary; built to construction grades of 1 in 15 or so to start with, so that in ordinary country a rough railway line can be built along the final route to embankments ahead (as well as in rear) of the digger; and this track is relaid to a lower level through the cutting itself as the digger starts on a new and deeper "slice" through the hill. Track-laying is thus occasional (instead of continuous, as in deep-cut method), but involves a considerable length whenever a slice is completed. While the track is being relaid to a new level, the digger can be washed out and have minor repairs done. The digger must move back into position for the new slice before it is immobilized, and before new track is laid on the level just completed. An example of a cutting driven on the layer method is given in detail later, and is illustrated in Fig. 4.

Digger Limiting Dimensions.

(11) In Fig. 1 the depth (D) of each "slice" clearly cannot be greater than the clearance (K) between digger floor level and open bucket door at maximum height and reach, less the height (H) of highest railway wagon to be used, and track on which standing.

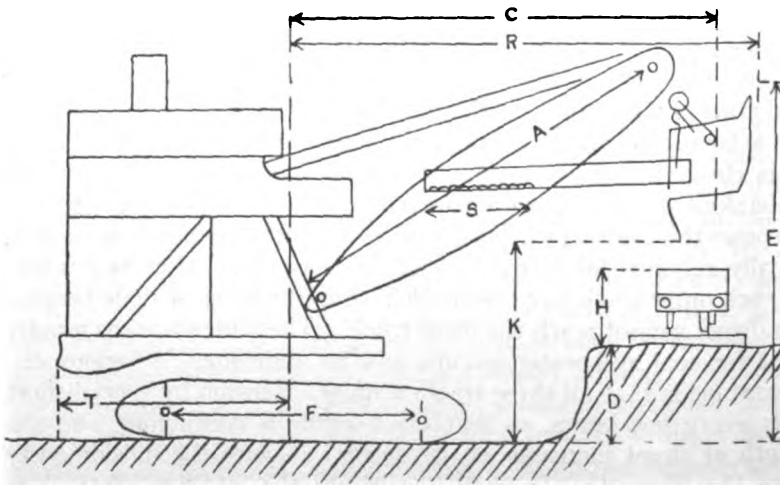

Fig. 1.

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Owing to uneven floor and railway track, in practice the driver must have a safety margin of about 1 foot between open bucket door at maximum height and top of truck, or his speed will drop seriously in order to avoid overwinding the bucket. Therefore :—

$$K = D + H + 1 \text{ (all in feet).}$$

K is easily determined and is laid down by maker for each size of digger. Fig. 2 gives the leading dimensions of standard digger as made by one of several English manufacturers.

From Fig. 1 also it will be realized that in the deep-cut method there is a limit to the height of face on which any digger can safely work. The dimension E (*see* Fig. 1) is a fixed one, and if the height of face exceeds about $1\frac{1}{2} \times E$, there is a risk in certain soils of the digger burrowing under and then getting damaged by the fall of considerable volumes of earth. If there is any risk of this, that portion of face which tends to get undercut must be brought down, from time to time, by other means.

Layer Method Example.

(12) The scheme of work prior to starting excavation deserves careful thought, in order to save time by reducing the number of track, digger and water supply changes. The whole layer system is well exemplified in Fig. 4, which illustrates a 60,000 cu. yard cutting driven by a No. 6 Ruston digger at the Railway Training Centre, R.E., Longmoor Camp. In this case K is 12 ft. 9 in. (*see* Fig. 2), and with the particular rolling stock used economical depth of slice (D) was 5 feet. This example deserves careful examination in detail. The limits of each cut at each level require pegging out on the ground in plan, and the provision of level pegs during each slice is also a point requiring attention and frequent checking.

In this particular cutting sand, easy clayey sand, and veins of hard sandstone were met in turn. The sandstone dropped output to 200/300 yards per day, but previously 400 cub. yards per 8-hour day was maintained comfortably in wet weather under reasonably good conditions of water, coal and wagon supply, which were carefully worked out. The " carry " was up to $1\frac{1}{4}$ miles in one direction and $5\frac{1}{2}$ miles in the other direction, out of the cutting. Two locomotives were required continuously ; one with a single crew, the other with a double shift, enabling this locomotive to work before and after the digger had ceased work. A learner driver worked the digger during the dinner-hour of the regular driver, the machine thus working continuously for 8 hours. To avoid delays locomotives were watered at different times. The trains should be as long as the locomotive can handle loaded. This reduces the number of train movements for a given volume of earth moved. The weight of train depends on gradients—and the strength of off-loading parties, who must deal

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with trains expeditiously. In the particular case under review there were at first three trains each of ten 10-ton wagons. These were found to be insufficient if there was the slightest delay in the working of trains.

Later on, when the second or learner driver had become more skilled, when four trains each of ten 10-ton wagons had been put into service, and all lost time due to coal and water had been eliminated (*see* para. 14), when every man in the 6½-mile chain had realized his own importance in the sequence of events, the output reached 500/550 cub. yards (700/800 tons) per 8-hour day—in spite of bad weather. In the circumstances this can be taken as the maximum rate for a No. 6 digger, because the machine was working fast and continuously.

The steady progress in output (as all ranks became experienced and combined to eliminate delays) is clearly shown in the following Table :—

Period.	Average output per 8-hour working day.	Remarks.
First week	30 trucks	30 trucks used. Coaling and watering direct from truck.
Second week	40 ,,	
Third week	51 ,,	
Fourth week	62 ,,	40 trucks used. Coaling from dump. Watering by gravity pipe line.
Fifth and subsequent weeks	70 to 78 trucks	

The trucks were 10-ton capacity ; which equals about 7 cub. yards. On the average it required 12 bucketfuls to fill one truck.

LABOUR.

(13) The labour engaged in producing the above result was :—

	Men.	
	Skilled.	*Unskilled.*
1. Digger crew (driving, firing, coaling, trimming and watering by gravity). Continuous work throughout 8-hour day	4	1
2. Three train crews, each of driver, fireman and shunter (2 locomotives, 1 working double shift)	9	—
3. Front off-loading gang, 1 mile ahead of digger, including lifting and packing on banks extending over ½-mile	—	15
4. Track maintenance party for 1 mile of temporary track in front of digger	15	—

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	Men.	
	Skilled.	*Unskilled.*
5. Railhead party, inserting culverts, extending track, building passing-loops, etc.	18	10
6. Rear off-loading gang, 5½ miles in rear of digger, including lifting and packing on bank ¼ mile long	—	40
7 Rear track construction and maintenance party for ¼ mile bank under construction	12	—
Total	58	66
Grand Total ..	124	

Average output per man per 8-hour day was thus 4½ cub. yards (nearly 6 1/3rd tons), including getting, carrying 5½ miles, new track construction and maintenance, placing in embankment, and lifting and packing as work progressed.

The above excludes a few men engaged on lighting up locomotives, maintaining locomotives, digger and rolling stock, and on maintaining and operating the 5½ miles of old main line behind the digger, over which earth-trains were running.

Photographs of the works described in the layer method example are shown at Figs. 5, 6 and 7.

Coal and Water.

(14) Diggers on service will almost certainly be driven by oil or steam, and not electrically. Steam involves frequent coaling and watering. The amount of coal and water usually carried by the digger itself is sufficient only for about 1½ hours' work. If water and coal is taken each time direct from a railway wagon (which is frequently done) much time is lost per day in shunting up the appropriate trucks; and it pays handsomely to arrange that these wagons come up only once a day if possible. With coal this is easy. Boxes and baskets can be filled prior to digger starting work, and kept as an easily-moved dump near the digger itself. Water-tanks can be similarly sited and the digger-tank replenished therefrom by hand-pump. These tanks can be filled from a tank-wagon once a day prior to digger starting work; and moved forward when empty at night prior to refilling. A better scheme can sometimes be arranged by siting a tender or large water-truck on a temporary spur at the summit of the cutting and leading thence a pipe-line coupled permanently to the digger. If the last 50 ft. or so are flexible, the digger pulls this along as it moves forward; and the digger-tank is replenished by

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FIG. 2.—DIGGER LIMITING DIMENSIONS (APPROX.).

THE DIMENSIONS REFERRED TO ARE SHOWN IN FIG. 1.

Size of machine.	Centres of jib. A (ft.)	Maximum centres discharge C (ft.)	Stroke of bucket S (ft.)	Wheel base F (ft.)	Working gauge (ft.)	Tail radius T (ft.)	Height open bucket door K (ft.)	Maxim. horizontal reach R (ft.)	Maxim. vertical reach E (ft.)	Bucket capacity cu. yards	Net weight (empty) on rail wheels (Steam driven) tons.
No. 6 Digger	20	22	6½	7	6½	9½	12¾	24	18¾	¾	17
No. 10 ,,	24	28	8	8½	7¾	11½	17½	31½	26	1½	32½
No. 15 ,,	28	29	10	8¾	8½	13½	17	32½	27	2¼	42
No. 20 ,,	31	32	12	10	9½	15	19	36	29	2¾ or 3½	56
No. 30 ,,	36	38	12½	12	12	21	20	43	32½	4	120

Note.—Longer jibs and longer racking-arms can be fitted with corresponding reduction of bucket-capacity, in each size of machine.

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gravity by opening a stop-cock at the lower (or digger) end whenever necessary. This arrangement was adopted in the example quoted in previous paragraphs.

Railway Gauge Problems.

(15) As explained earlier, the fundamental problem is to keep the digger supplied continuously with empty trucks actually at the digger itself. This raises questions of principle. A small digger with ¾-yard bucket with a good driver in average soil can easily take three mouthfuls per minute, *i.e.*, it can load, say, 2½ cub. yards per minute. The larger the digger the slower its cycle; but the actual number of cub. yards loaded per minute increases because the bucket size is larger. From this it can be seen at once that the unit for "carry" should be as large as possible—otherwise a very large number of wagons are required with corresponding traffic congestion. On road work one frequently sees the 60 cm. railway and tip-truck used with a digger, because a standard-gauge railway is perhaps not worth building to the site. One bucketful of even a small digger fills one 60 cm. gauge tip truck. The number of tip-trucks required to get full value out of the digger can therefore never be provided in practice; in fact, if they were, traffic congestion would soon bring matters to a standstill. In every case of works which have been visited, where the 60 cm. trucks have been used, the digger has been standing idle (waiting for trucks) for half its time in steam. The remedy is obvious. Wherever possible, build a standard-gauge railway (of the gauge already in the country) and use the highest-capacity trucks available, but of a type suitable for rapid off-loading.

Track Problems.

(16) The track used for heavy earthworks is largely on banks which are continually settling. The track is usually unballasted and temporary, *i.e.*, built with sleepers and rails which have to be respiked repeatedly as the track is moved forward (deep-cut method) or lower down (layer method). On service, locomotives heavier than the usual light contractors' engine will invariably have to be used, and the loss of time and disorganization due to even minor derailments necessitates a strong permanent-way maintenance party of, say, 10 to 12 men per mile. Periodically this party requires strengthening from off-loading gangs when relaying track to a lower level takes place in the cutting itself.

Near any large cutting it is imperative to have at least one temporary service-loop—preferably one at each end of the cutting. A service-loop near a big embankment is also essential if delays are to

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be avoided. These loops need only be just long enough to pass the maximum earth-train length, including engine or tractor, and brake-vans if any.

RAILWAY OPERATING STAFF.

(17) Each locomotive should have with it a staff of one engine-driver, one fireman and at least one shunter. Two shunters are preferable for standard-gauge trains, owing to the length and necessity of pinning down or unpinning each wagon-brake when negotiating severe construction gradients. Owing to the low speeds on tracks under construction, ground staff of all sorts (*e.g.*, blockmen, flagmen, etc.) can as a rule be dispensed with, and trains work "at sight" between the various passing service-loops. This may cause loss of time, however, if distance between passing-loops exceeds, say, 1½ miles. Time spent on temporary passing-loops is usually time saved in the case of big works.

ORGANIZATION OF DIGGER PERSONNEL.

(18) The digger crew consists essentially of one driver, one fireman, and at least one man on the ground. For maximum and continuous work throughout the day one other relief driver, and a fifth man, can be employed on trimming the ground, coaling (by basket) and on water duties. One driver should definitely be in charge and responsible for oiling and maintaining the machine. The digger should not as a rule cease work during the meal or rest time of any of the men, providing empty trucks continue to arrive. It is advisable, however, to lay up the digger one day per week for minor maintenance, examination and cleaning of wire ropes, pulley blocks, caterpillar tracks, etc. As regards mechanical failures, prevention is better than cure. Digger-driving is hard and exacting work when working at top pressure. In bad weather the driver is exposed, and there is always a strong tendency to overwork a good man, particularly when output drops. This must be resisted, and output can frequently be raised by looking elsewhere than at the digger itself.

An officer or experienced N.C.O. should be within range of the digger throughout, and will be responsible for arranging reliefs, coaling, watering, and shunting movements well in advance. He is in effect the Officer Commanding a company of 300 men, in the case of a large digger, concentrated at one point, the bucket of the digger. His duty is to see that his "300 men" work continuously without delay from any cause whatsoever. A really good man in charge at this point has invariably an incredible effect on the output. It will be appreciated that the actual driver is far too busy to attend to all these complementary details.

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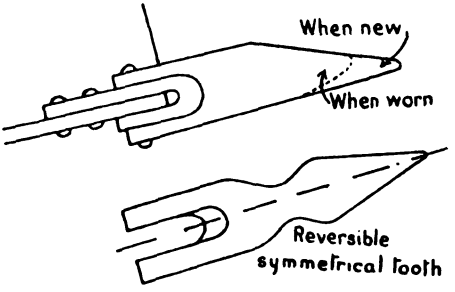
Other Points of Importance.

(19) A digger is not a tool of great precision. It is waste of time to make the driver dig to nearer than say six inches in level, and final trimming to formation level on the final cut should be by hand. Side slopes should be trimmed down as each layer is carried through. Otherwise in a deep cutting considerable volumes are left " high and dry," so to speak, and may involve several throws by hand later before this soil can reach a wagon. If a digger digs the formation out too deep this can always be filled in. If, however, it gouges out a hole in the side slope this should never be filled in, as the filling will always wash into the cutting in wet weather.

(20) The layer or slice taken by a digger at each level should be made self-draining in wet weather by always making the digger advance *uphill*. This should always be possible to arrange on the layer system—except possibly for the first slice, which is the least important from a drainage point of view—because roads or railways in cutting are invariably on a gradient. On the " deep-cut " method drainage may become a serious problem if the advance is downhill—another disadvantage of this method of working.



(21) Another point of importance is to keep the bucket-teeth sharp. When new, they are generally to the shape shown in sketch. When worn, the teeth will not lead the bucket into the face of the cutting, and it is difficult to get a full bucketful at one " bite." The loss of efficiency is most marked in hard soils. The teeth can then be ground or reversed, if reversible teeth are fitted. The latter is preferable, as being quicker, and it avoids changing the shank. Normally four teeth are fitted to a bucket irrespective of size of bucket.

Teeth are made of manganese or carbon steels, depending on the soil. Soil which causes heavy wear on manganese steel will not be so

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destructive to carbon steel. The latter is usually better in sandy soils, but the wear is very uncertain, and it is not easy to foretell which material will wear the better.

OFF-LOADING.

(22) The organization and strength of off-loading parties depend so much on the method of forming the bank, type of truck and time available for off-loading, that it is only possible to state that the number normally varies from 2 to 4 men per 10-ton truck. There is usually a shortage of trucks. Therefore, the moment a train arrives, gangs should start off-loading and stop lifting, packing, slewing, spreading or whatever else they may have been doing. All this can continue after the train has been sent back empty. Meal-times should also be arranged between trains. Four unskilled men should empty a 10-ton drop-side truck in about 25 minutes, off-loading both sides.

In off-loading, it is important to tackle the job on as broad a front and *as evenly as possible*. If, in the early stages, an embankment is formed with local " pockets " or places where there is a shortage of earth, sooner or later trains have to be broken up and trucks placed opposite these pockets for off-loading. This means delay, possibly involving a shortage of empty trucks later at the digger.

For similar reasons when loading trucks the digger should take out the excavation evenly and fully, before moving forward in a cutting.

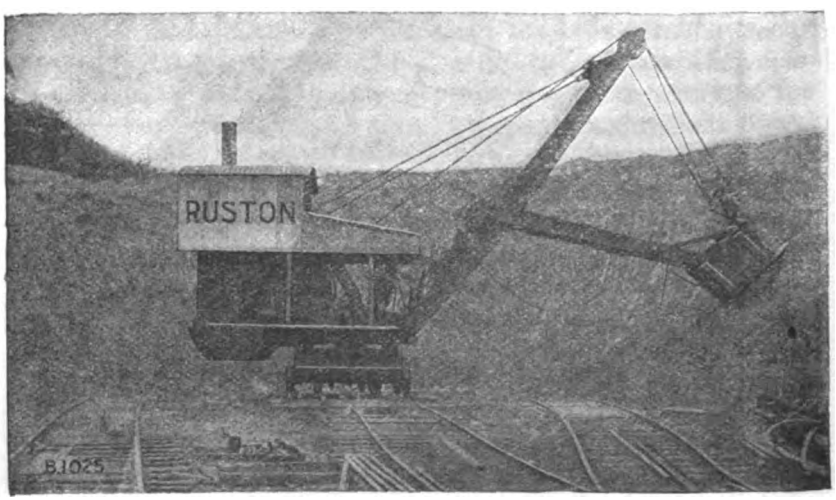

FIG. 3.—Ready for track laying.

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HEAVY EARTHWORK.

FIG. 4.—The layer method of working No. 15 size Digger. In this instance two loading-trucks are available. This reduces losses due to shunting, but will seldom be feasible for narrow cuttings driven on active service.

FIG. 5.—Boiler washout and minor repairs. Where the track disappears, it dips suddenly at 1 in 20 to reach the embankment shown in Fig. 6.

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FIG. 6.—The embankment at S. end of cutting in process of construction.

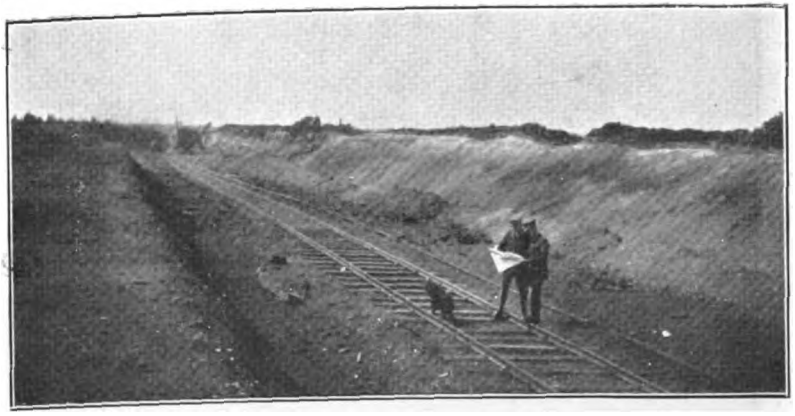

FIG. 7.—Looking towards Liss, track falling at 1·5 per cent. (1 in 66).
Trimming of side slope completed for half the length of cutting, spoil to be loaded by digger on cutting the next layer. The track shown is 10 feet (2 layers) above the final formation level. The pipe for digger water supply can be seen behind the officers. High-level track for tender supplying water is on the left and above camera level.

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Digger-Drivers.

(23) It remains to state that really good digger-drivers can be recruited from the ranks of any steam-engine drivers and firemen, but they are not produced in a day. Speed takes time to acquire, and should not be forced upon men. With inexperienced drivers (and they will mostly be that on mobilization) *safety* is the first consideration—otherwise they are apt to cause an accident and put the equivalent of "300 men or more" into hospital at one fell swoop. The heavy repairs may take days or even weeks, and the result on the work as a whole may well be disastrous. Safety first, therefore, and speed will develop naturally and very quickly. As might be expected, the younger men pick up the art quickest, and many of the older and more experienced drivers of other more staid types of steam-engine (*e.g.*, locomotives) seem incapable of ever mastering the bucking, swaying digger.

Conclusion.

(24) All engineering work as a rule can show the value of co-ordinated effort, but none more truly so than a constructional job involving heavy earthwork. Graphical charts of output at the cuttings and input at the embankments should always be kept, and carefully watched. Once any figure which proves to be a maximum up to date has been reached at any point, an effort should be made to hold it regularly, and with certainty, by checking over details and timings over the whole job. The reason why the maximum was not reached before may then perhaps be found to be a link several miles away which was not always giving its best.

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THE FUNCTION OF THE MILITARY ENGINEER IN THE ARMY OF TO-DAY.

"PAS DE CULTE SANS MYSTÈRE?"

(Reprinted from *The Army Quarterly*.)

THERE is a very distinct feeling abroad to-day that all those who deal in any particular branch of science take especial pains to surround their profession with mystery. Whilst it may be possible to afford the luxury of this atmosphere in civil life, such a practice, by any arm or branch of the Army, is at once fatal to the attainment of that high degree of co-operation which is demanded to-day, more than ever before, if the various arms employed are to attain success in battle.

And therefore, whilst a layman may argue that the military engineer is beyond his comprehension both as regards method and mentality, it can be said from bitter experience that no one can suffer more from being misunderstood and misapplied, than can the military engineer, and consequently the laity can rest assured that he does not consciously strive to extend the alleged atmosphere of mystery. *Esprit de corps* is a wonderful thing, but ignorantly and shortsightedly encouraged it may promote a state of self-sufficiency, an air of aloof mystery, resulting in a total incapacity to understand, and consequently to co-operate with, another arm. Of latter years, the function of the military engineer has become somewhat dimmed even to the engineer himself, and it is therefore not altogether unprofitable to sit down quietly now and then and consider this matter.

The Army is designed to deal with two kinds of war—a small war and a world war. In the first case, it will rely upon existing resources within the Army; in the second, it will cover and train a striking force to be raised from that portion of the nation's man-power to be allotted to the Army.

It would seem fair to say that the magnitude of the jobs to be undertaken will be greater in a world war than in a small war. It is also considered accurate to say that, whilst in a small war the existing military engineering personnel will usually be sufficient for all demands made by the Regular Army, in a world war the majority of the engineer officers will be drawn from civil life.

In a small war the greater proportion of the regular military engineer officers will be employed in an executive, as opposed to an administrative, capacity, whilst in a world war the situation is likely

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to be reversed, and we shall find a larger proportion employed as administrators. They will be required to handle the civilian-recruited engineers who will be brought in to carry out executive duties.

There is no mystery about the executive side of military engineering to-day. (Probably the term " military engineering " is daily becoming more and more of a misnomer, and some such expression as " the adaptation of engineering practice to military requirements " explains the profession of the military engineer much more faithfully.) Consequently, a civilian engineer, as was proved in the years 1914–18, can soon take his place on the executive side. It is on the administrative side, however, that the necessity for military experience is required.

The military engineer should not be, and humanly cannot be, an expert in every branch of engineering, but this does not imply that there does not exist a very definite profession, having a technique peculiar to war, which it is the duty of every engineer cadet and junior officer to master in due course. But the employment of the military engineer during the early years of his service in an executive capacity is only part of his training to arrive at the finished product and therefore, in the subsequent discussion of this subject, it is not the subaltern or captain who is visualized when referring to the military engineer, but rather the holders of the higher appointments open to the profession.

One of the basic principles on which our Army is prepared in peace and operates in war is that it should rely on civilian resources to the greatest possible extent, not only for man-power, and material, but also for its technical experts. (The exceptions to this principle are the man-power, material, and technical experts peculiar to the art of war.) These latter make up the peace-time Army, in its broadest aspect, from and on whose framework the National Army is expanded in a world war.

Just as in peace we require a certain proportion of the nation's man-power in the Army for training, experiment, and as a shield under which the National Army may be trained and developed when a world war arises, so we require to possess, in peace, certain material which is peculiar to the art of war. In no less degree do we require certain professional experts included in the Army in peace, whose attainments are peculiar to war and it is amongst these that we can number the General Staff, and the military engineer—to mention only two around which this discussion will centre.* It has been hinted at the commencement of this article that the functions of the military engineer are not too commonly appreciated, and, in fact, as its title

* Care must be taken not to confuse the professional experts within the Army—the General Staff and the military engineer—with the engineering specialists of detail—the designers. The General Staff are expert soldiers ; in no less degree is the military engineer an expert at his profession as herein defined. The technical specialist is the designer who is expert in *one* only of the following—automobile engines, 6-in. guns, 15-in. guns, chassis design, armour, bridge design, etc., etc.

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suggests, this article is an attempt to elucidate that very point. And so it is considered that the best starting point will be a brief examination of the influence on engineering of the art of modern warfare.

The late war was remarkable for a number of things, but one of its more outstanding features was the tremendous fillip it gave to scientific development. Recall the advances made in chemistry as evidenced by poison gas, new high explosives, smoke, and synthetic oil; in metallurgy, as demonstrated by the guns evolved, and the increased efficiency of the internal-combustion engine, with its far-reaching effect on the aeroplane, mechanical transport, tanks and the greater use of power to increase the output of the individual; in electricity, as witness the improvement of wireless telegraphy and the "arrival" of radio telephony. Whatever the branch of science considered, wonderful achievement and development was recorded, and since it was the urge of war that begat all this progress and development, it should not be a matter for surprise that the Army of to-day stands on the threshold of a new era.

Chemistry, Metallurgy and Electricity—it is hard to know in which order to place the first two—have possibly made the greatest mark on the military machine so far, but we are only at the beginning. Chemistry, poison gas—can so completely and absolutely revolutionize the military machine that the question, "Are we giving the potentialities of gas sufficient weight in our present policy?" must be left undiscussed in this article.

At the present moment, however, it is the fruits of metallurgical research which have made the deepest mark on the Army, for it is this more than anything else that has made possible the development of the internal-combustion engine. This prime mover has freed the Army for all time from the limited tractive effort of the horse. It spells to-day increased mobility, and this reacts in numerous directions to re-establish tactical manœuvre, to reduce distance, to conserve physical energy, to provide a greater degree of human comfort, and to build up morale. It also provides power—almost unlimited power—which can be transported even into the battle area, the utilization of which will increase the capacity of the individual man to do work.

Up to date, the development of the science of electricity has been mainly in the direction of improved communications. That improvement was required, before the Army attained its new mobility, will not be denied. How much greater will be the responsibility placed upon communications as a result of this new mobility, in order to ensure that the standard of co-ordination and co-operation does not decline? Even as we write comes the promise of the transmission of electrical power without the use of wires. To what use will the Army put such an achievement?

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During the course of the War the journalists evolved a series of epithets—the "chemist's war" blazed forth one day; then the "gunner's war," whilst the "engineer's war" was used almost to exhaustion point. The journalists may not always be right, but there will be few who will quarrel with the broad but moderate assertion that engineering science is to-day a rapidly increasing influence on the Army.

At the moment, the greatest problem before the Army is what is popularly called "mechanization," but which is not always defined, as it should do, to mean the utilization of mechanically-produced power both to gain increased mobility and to conserve physical energy, or alternatively, to increase individual output. No one is likely to minimize the various problems which, it may reasonably be expected, will be met with in effecting this "mechanization," and the several scientific developments "pending," which are likely to materially affect the Army, can be relied upon, in no less degree, to produce a similar number of problems.

The situation is really this. The urge which the late War gave to science has placed us in possession of a number of tremendously potential developments of the science of mechanical engineering. The potentiality of these developments is so immense that we suddenly find ourselves with a huge accumulation of engineering knowledge requiring assimilation into the technique of war. Hitherto the evolution of the technique of an Army has been spread over a period of time measured in centuries. It has been so gradual as almost to escape notice. It has been measured, as it were, by the hour hand of the clock.

To-day, we are faced with something much more in the nature of a definite operation. There is so much new knowledge to be worked in—it is no longer a gradual process, we have to move with the minute hand of the clock. It can no longer be described by the term evolution—it becomes much more nearly a definite military operation of peace.

Let us now discuss the three professions which must co-operate to effect this operation of peace. We have the General Staff, and the Military Engineer, both of whom are peculiar to the Army, in peace as in war, and we have the Engineering Designer, who is invariably outside the Army, but who may spring from either a military or a civilian source.

First of all then, there is the General Staff—the professional soldier, the director, the man responsible for the policy and the framework of the Army, but who is, nevertheless, a layman in the face of engineering science. Now civilian engineering endeavour does not normally aim at producing a weapon of war. Consequently it is not to be expected that the General Staff can, as it were, go up to the counter of engineering development and pick off the shelf those inventions and

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ideas which it considers it can utilize for the better prosecution of war. It must be clear to anyone that this would be a wasteful process—wasteful of money and wasteful of effort. The man who goes to the counter should be a military engineer. The military engineer has a definite and continuous duty of an operative nature in the Army. That is to say, he has to put through the current and ordinary engineering work of the Army, but he should also have this other highly important, highly skilled function—he should interpret the policy of the General Staff in terms of the engineering developments of the age. It is not the duty nor the intended function of the General Staff that they should be able to speak the language of the science of engineering. They are the high priests of the art of war, and that is a full-time job.

It will be readily conceded that the necessity for the military engineer acting in this consultative capacity has not existed for some years now. When fortification bulked largely in Army affairs, we found the military engineer definitely established and his profession was duly acknowledged. Since then there has been a hiatus, nothing has arisen on such a predominant scale to take the place of fortification. But now—overnight—mechanical engineering has appeared and the niche of the professional military engineer has suddenly become patent to all. Perhaps the day after to-morrow it may be that the military engineer may require to possess a chemical bias, just as to-day he requires to have a mechanical leaning. And thus arises the urgent necessity for a re-orientation of view and a recognition of the necessity for utilizing the technical abilities of the military engineer in the highest councils of the Army.

The military engineer should be required to appreciate and analyse the purely military requirements as enunciated by the General Staff, he should then weigh them against engineering development as it stands at the moment, he should advise the General Staff of the limitation which the current stage of development may impose on their stated requirements, and finally, having reached a compromise with the General Staff, he should be the agent to present to the particular engineering specialist a picture which his engineering knowledge tells him is feasible.

The engineering specialist is the third party in the triumvirate now under consideration, and it is essential to realize clearly his functions and his limitations. No portion of the Army subject to military law is trained with a definite view to the production of engineering specialists in those branches of military maintenance which fall under the heads of research and design, except as mentioned below. The cadre Army of peace, no less than the National Army, cannot train from amongst its officer personnel the automobile designer, the bridge designer, the metallurgist, the chemist, or the electrical designer, whose services it nevertheless requires. As far

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as possible the Army adapts and utilizes civilian design and practice; over and above this, the requirements pertaining solely to warfare must be obtained by the subsidization of certain civilians, together with a number of officers drawn from all Corps and arms who display especial aptitude and are mentally fitted for this very specialized work. For example, since the gun is peculiar to war, the Army trains a limited number of artillery officers as gun designers. Too much stress therefore cannot be laid on the difference between the two professions of engineer designer, whatever the particular branch, and the military engineer. There is much ignorance on this point amongst the laity, and it is as well that it should be clearly recognized that the designer is the highest degree of specialist in one branch of engineering only, and that this is precisely the last quality required of the military engineer.

There is, however, little doubt that the misunderstanding is largely due to the fact that it has become less and less the habit of mind to look upon military engineering as a very clearly defined profession. The mechanical engineering maintenance work of the Army until 1914 consisted mainly of artillery repair and maintenance, and was cared for by a corps separate from the accepted military engineers.

The appearance of further mechanical work in the shape of mechanical transport saw a third corps undertake maintenance work of a mechanical nature. Whilst this latter development was doubtless largely done under the stress of war conditions, the fact remains that it is this splitting up of the mechanical engineering work of the Army among several corps, coupled with the absence of any co-ordination of the *control* of engineering design and research (not the actual design and research) under one military engineer, trained as such, which has created the anomalous position, greatly aggravated on the appearance of wholesale "mechanization," that to-day the professional soldier has not one professional military engineer to advise him on modern engineering development as a whole. Now it is here contended that this is the true function of the military engineer. He must be the consultant—the counterpart of the general medical practitioner—the diagnoser, the appraiser. He must speak the language both of the General Staff and of the civilian or military expert designer.

Whilst the existing organization within the War Office provides certain branches which are charged with the duty of interpreting as between the General Staff and the particular section of engineering design with which they deal, these branches are not, as an accepted rule, staffed by military engineers, although they carry out work which is essentially military engineering. Staffing these branches in this manner is bound to result in design and research being pursued along restricted channels, with consequent waste and limited results.

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The staff of these branches, from the director down, should be chosen from amongst the most highly trained military engineers available for each grade, versed in all branches of engineering science, and practised in the application of their knowledge, so that they can appraise to the full the significance and possibilities of inventions and discoveries in respect of the particular duties with which they are charged. Some idea of the type of work expected of these branches may be gathered from a hypothetical consideration of tank design. The General Staff desire a weapon to combat the machine-gun and stipulate that it shall be capable of travelling 40 m.p.h. cross-country, carrying an armament of 4 machine-guns and one 3-pr. gun, and armour which is proof against 3-pr. shell. Co-ordinative work of this type is essentially the military engineer's. He, as a combatant officer, can appreciate the niceties of the purely military proposition which he is directed to solve; he knows the users' requirements and appreciates the natural obstacles met in the field. On the other hand, he knows in general terms the ratio of power to bulk of the internal-combustion engine, as well as its inherent limitations; he realizes the painfully low efficiency of the track, and consequently he can say to the General Staff, without hesitation, that to produce such a tank, until the track can be improved, is, at the moment, impossible. The low efficiency of the track, and the engine in its present stage of evolution, make the carrying of such a load of armour and armament at such a speed impossible unless a 4,000 h.p. engine is used. This will reduce the space available within the vehicle by some 200 cubic feet, and results in its being unfightable. He may say, we can give you an unarmoured vehicle to move cross-country at 20 m.p.h. with no room in which to fight four weapons, or we can give you a 3-pr. proof vehicle to move 4 m.p.h., but if a balance between armour and speed and fighting ability is desired, then the tank will be ·303 inch proof and travel 15 miles per hour cross-country.

It is not for the layman to appreciate, for example, the inherent inefficiency of the track as opposed to the natural efficiency of the wheel; it is for the military engineer to point out the necessity for further research on the track before expending further money on a complete tank. The military engineer is also in the best position to report to the General Staff on such a subject as the commercial progress of the utilization of power to increase the output of the individual employed on field engineering. He will be technically able to advise that instead of doubling the number of men in a field company, the possession of a prime mover within the unit, operating the requisite tools, will enable each sapper to double his output when dealing with the multifarious requirements of fortification, demolition, and obstacles in the field.

Again, in the criticism of what may be termed erectable equipment he will play his part. It will be his responsibility to explain to the

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civilian designer those general military requirements which influence bridge design. He will show that loose bolts, odd pins on chains, long lengths of vulnerable screw thread, are so much waste of time, labour, and money, if incorporated into a military structure. For the expert does not necessarily appreciate that simplicity of design, which is demanded of a structure that has to be assembled and erected by night under fire, and only the military engineer can explain this efficiently.

But there is a still wider aspect of this linking of civilian and military experts by several War Office branches which it is contended should be staffed by military engineers. The military engineer is peculiarly fitted to fill the higher rôle of co-ordinating all these branches. In such a position a military engineer is technically fitted to realize, so soon as he sees the General Staff using fighting vehicles in the forefront of the attack and in support of reconnaissance troops, that heavy assault bridges will be required, and he will be in the best position to direct the bridge designers on to this problem.

Every new device, every single application of a new weapon, has its reaction on a number of other devices, weapons, and previously existing conditions. If you produce a highly efficient anti-tank gun, you influence tank design, you may require a faster or a more highly armoured tank. If you produce a heavier tank, you need a stronger bridge. If you can successfully utilize the anti-tank mine, the calls on anti-tank gunnery are lessened. If by mechanical means your field engineers can remove woods overnight, the demands on your tanks are decreased. If by means of a more efficient mounting you can improve tank gunnery, you may require to increase the armour on your anti-tank gun or your self-propelled 18-pounder gun. The anti-tank gun may make the tank a mere death waggon, but the successful control of smoke may revivify the tank and make it a practical proposition again.

And so it is that, whilst reconciling the desire for a heavy tank with the necessity for progress in bridge design in order that a heavy, and, at the same time, quickly-erectable bridge may be available, the military engineer must also correlate the progress in these two branches with the current stage of evolution of obstacle construction, anti-tank gun development, with smoke and with gas. In order to attain the greatest all-round efficiency of the Army, the fighting machines must be evolved as a co-ordinated whole; otherwise, it is not difficult to visualize at some future date that the advanced evolution of one part of the military machine may be nullified by lack of progress on some other part, or alternatively, that one part of the machine may be advanced along a special line, and be at total variance with the most likely avenue of advancement of some other part. It is undoubtedly in this highest position of all that the technical, consultative advice of the military engineer will tend to the more

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rapid production of what the Army really needs in the way of engines of war.

Not only will such co-ordination produce the New Army in the most efficient form in the shortest time, but much money will be saved. The military engineer can lay down the lines along which development can most economically proceed. Instead of building the complete experimental unit, he can show that economy lies rather in research and experiment on the weak link of that unit, until such an appreciable advance has been achieved that it is justifiable to include the improvement in the standard unit of which the Army is in possession. But make no mistake of this fact—the military engineer who can explain the military limitations which, of necessity, must be superimposed on the pure engineering design, could not himself produce the detailed design for the vehicle or the bridge or the gun, or whatever it may be. It is not his business ; he is required to stand back, and get a much larger view of the situation. He does not deal in 3/16 inch here and 5 mm. there. He simply writes the specification. The foregoing merely suggests some of the functions which should belong to the military engineer, more particularly on the mechanical engineering side.

There may be some who will argue that the production of such a man as the military engineer has been described to be, is not possible —but it is only a question of degree. Just as the C.I.G.S. interprets the arms of the Army to a lay Cabinet, without himself being an expert in every arm of the service, so it is necessary to-day to have a military engineer placed in such a position that he is charged with interpreting to the General Staff the numerous specializing experts of the engineering profession in terms of the policy of that Staff. If the military engineer's training is right, there is no shadow of doubt that such men can be produced, and are, in fact, available to-day. It should be realized that this is a professional affair. The military engineer should stand apart as the co-ordinator of a number of experts in different branches of engineering, for just as the commander cannot win his battle if he is for ever shooting with the infantry or ranging with his gunners, in similar degree he cannot afford to entangle himself with his many engineering experts.

Now it has been shown that military engineering is a very definite profession, requiring very definite qualifications from its professors. For many years now much money has been invested in the education and theoretical training of one particular corps—the Corps of Royal Engineers. This training comprises the broadest possible theoretical engineering education at Cambridge University. A period of applied practical training in military material at the School of Military Engineering. A period of wide and varied practical apprenticeship with civilian mechanical and electrical manufacturers and consultants. Experience in combatant duties and co-operation with the other arms

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of the Army through its Field Companies. On foreign service its officers gain experience under every conceivable climate and set of conditions as mechanical, civil, electrical, and railway engineers, and as surveyors. As a result of the possibilities offered by this unique training and experience this corps alone possesses the officers with the necessary qualifications to fulfil the functions to be required of the military engineers of the Army.

In view of the large sums invested in the Royal Engineer's education, it is not unnatural that the General Staff—the professional soldier—should require to see a very definite return for all this investment, and no one realizes better than the Corps of Royal Engineers that they are not giving all they could to the common cause—the efficiency of the Army. But unless he is invested with the responsibility, the Royal Engineer cannot produce the desired results. He is merely one of the still small voices crying in the wilderness, hoping against hope that one day he will be utilized as he should be.

It is not a piece of professional jealousy if the military engineer points out that the gunnery expert, the automobile expert, or any other expert, cannot, on those qualifications alone, fulfil the professional requirements of a military engineer. We have only to turn to recent history to see how the military engineer has fulfilled his true function in spite of lack of official recognition. It was his sound military training, coupled with his knowledge of engineering, which enabled General Sir E. Swinton (late R.E.) to appreciate the situation on the Western Front in 1914 and write a specification for an engine of war—the tank—which successfully dealt with the hidden machine gun. More recently still, it was Major Martel, R.E., who, appreciating the need for individual mobility above that possible with limited human powers, evolved the tankette, and demonstrated the way in which the internal-combustion engine might be utilized to gain increased mobility for the individual.

Recognition of military engineering as a profession may be hailed as something new; in point of fact, it is more in the nature of a revival, since it is only of recent years that the influence of engineering on warfare has once again accumulated sufficiently to be obvious to the layman.

All that the Royal Engineer asks is to be officially charged with duties which have been usurped by either non-technical corps, or by specializing experts, and he will produce the results and pay the dividend on the capital invested in his education.

It may then be asked, assuming that he is charged with the co-ordination of the experts, why should he also require to be charged with the maintenance of the machines of war? The reasons are two in number. The military engineer requires in peace all the practical experience and training that he can get. Everyone realizes the difficulty of finding practical training for the Royal Engineer economically

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in peace. Why then bestow all the highly theoretical training on this one corps, and divide the practical training afforded by the maintenance of the engines of war among two other corps? The other reason is financial. If mechanical maintenance is to be carried out by the R.A.S.C. for the supply lorries, and by the R.A.O.C. for the guns and so-called mechanized vehicles, it will inevitably entail duplication and overlapping. Mechanical maintenance, whether of 4-wheelers, 6-wheelers, half-track or full-track vehicles, or of guns, can all be carried out under one roof in one mechanical engineering workshop. The materials and processes of manufacture and maintenance are in all cases the same.

In the next few years we shall undoubtedly see the Royal Engineers in possession of a great deal of mechanical plant for use by their field and army troops companies. Are they to open their own workshops for the repair of these engines, too? Are there to be three separate sets of mechanical engineering workshops in each divisional, corps, and army area?

To place the mechanical maintenance under one corps will save machine tools, buildings and power. It will economize in labour and supervision. It will economize in the number of boys' technical training schools required. Can the Army, on its present reduced Votes, afford to neglect the consummation of these far-reaching economies?

In conclusion, to summarize. It must be realized that the situation has materially changed since 1914. There exists to-day, owing to the ever-increasing importance of engineering within the military machine, a most definite niche for the military engineer as the co-ordinator of the many specialized branches of engineering. The Army has already complained that it is not receiving the benefits which it has a right to expect from the costly education of the officers of the Corps of Royal Engineers. This Corps is anxious to shoulder the responsibilities for which it has already been trained, and only asks to be definitely charged with them. These responsibilities mean —within the War Office—a co-ordination of the many engineering experts who work outside the War Office, and in the field or in the commands, responsibility for all mechanical maintenance, in addition to the responsibilities already possessed in respect of field engineering, railways and survey.

By such re-allocation of responsibility the Army will draw dividends on the capital invested in the education of the Corps of Royal Engineers; economy will be effected in expenditure, time and effort; and the General Staff will receive unbiassed engineering advice, commensurate with its needs, which is of such vital importance to-day when the foundation of a mechanized Army is being laid.

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RAPID BRIDGE CONSTRUCTION IN SOUTH INDIA.

By A. LAMOND, ESQ. (LATE R.E.).

THE following article will doubtless prove of interest to members of the Institution in that the methods of construction are new, and the rate of progress in erection exceedingly rapid. Applied to modern railway extensions, involving large bridge projects, considerable saving in time is effected in actual construction, which in turn reduces the cost of new schemes and enables a return on capital expenditure to be realized very much earlier than is possible when the usual more prolonged methods of construction are adopted.

The construction of the Chord Line from Villupuram to Trichinopoly on the South Indian Railway involved the bridging of eight large rivers. Referring to the accompanying map and commencing from the north, the following rivers had to be bridged :—Ponniar, Malattar, Manimuktanadi, Vellār, Marudiyar, Nandiyar, Coleroon and Cauvery. The Gadilam River was not bridged by the same methods as these other rivers, owing to the prevalence of rock close to the bed surface.

Very careful consideration was given in the first instance to the type of bridge to be adopted, and ultimately a scheme for the supply and erection of screw-cylinder bridges, put forward by a Calcutta firm, was accepted by the South Indian Railway Co.

The beds of the rivers in general consist of a deep layer of sand overlying a stratum of clay of various degrees of hardness. The first six rivers are subject to floods only in the north-east monsoon, which covers the period from early November to the end of January. The Cauvery and Coleroon are subject to floods during the south-west as well as the north-east monsoon, as their source is up in the Western Ghats in Mysore State.

The working season, therefore, for the first six rivers was between the beginning of February and the end of October, and for the Cauvery and Coleroon between early February and the end of May. During the working season the beds of the rivers are more or less dry.

The economic span of these bridges was found to be 65 ft., and the distance apart centre to centre of piers was fixed at 65 ft. 3 in.

The advantages of the type of construction finally adopted are :—

(*a*) Rapidity of erection of sub-structure in founding at large depths.

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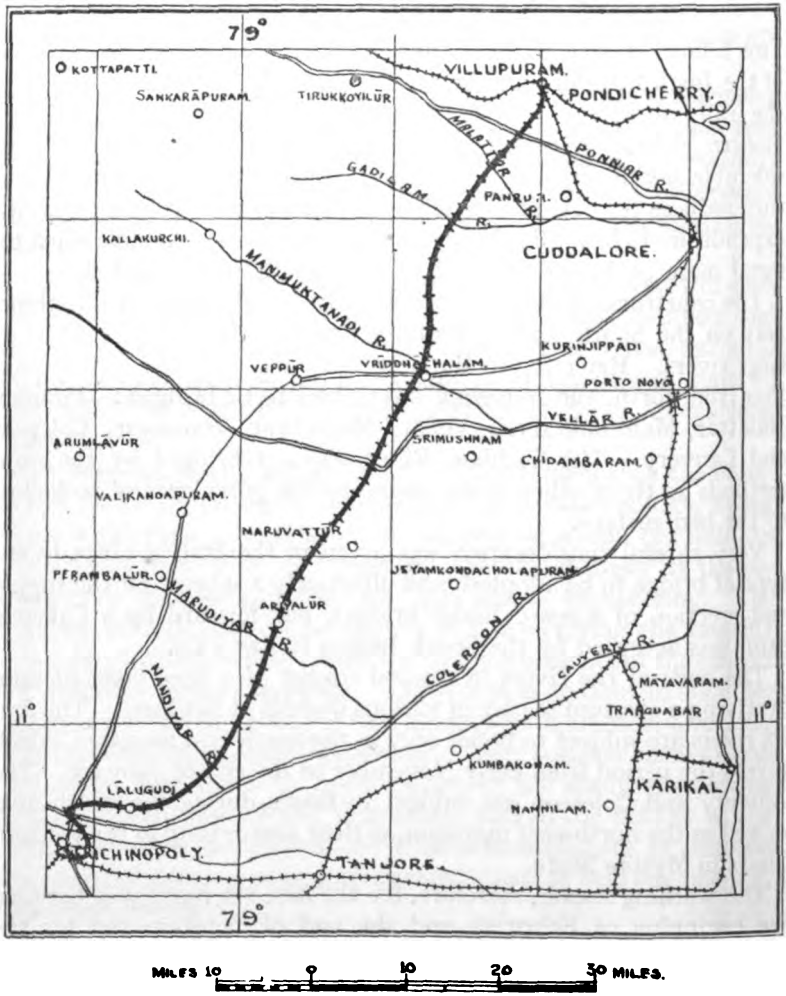
(*b*) Consequent early completion of the whole work, permitting earlier opening of the line and yielding a quick return on capital expenditure.

(*c*) Any bridge can normally be completed in one working season.

It was decided to commence operations at the northern end of the line, the actual construction commencing at the end of March, 1926.



The Ponniar and Malattar bridges (28 and 12 spans) were commenced first, and, although a period of seven months only was available, these were completed before the break of the north-east monsoon at the end of October. The plant was then transferred to the southern end of the line, and the bridges over the Coleroon and Cauvery

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(45 and 30 spans) were completed in the short working season of four months in 1927, *i.e.*, before the floods of the south-west monsoon came down.

This rapidity of construction was made possible by the adoption of the methods which will now be briefly described.

The sub-structure of each bridge is designed to carry a single-track broad-gauge railway, although for the present the line consists of a metre-gauge track and the girders are designed accordingly. It is possible that in the future this line may be converted to broad-gauge, which is the reason for making the sub-structure of the bridge capable of taking the increased loading when necessity arises.

Each pier or bent consists of two cast-iron cylinders, the outside diameter of which is 3 ft. The metal in the cylinders is 1 5/8th in. thick. The cylinders are placed at 9 ft. centres, and are cast in sections of 9 ft. long, each piece weighing about 2½ tons. The sections have internal flanged joints, the faces of which are machined, thus ensuring a close joint. Sixteen turned steel bolts 1¾ in. diameter connect these flanges together.

The two cylinders are braced together above bed-level by heavy bracing consisting of steel clamps fixed round the cylinder, connected at the top and bottom by channels and braced diagonally with 6 in. by 3 in. angles.

The amount of bracing used varies with the height of the cylinders above bed-level, and it will be noticed from the photographs of Ponniar and Coleroon piers that single-bay bracing was used on the former, and on the latter,* the piers of which are 13 ft. high above bed-level, a double system was adopted.

This bracing is fabricated and sent to the site in one piece, where it is drilled and fixed to the cylinder clamps by 1¾ in. dia. turned bolts.

The cylinders, which vary in depth in the river beds from 30 to 50 ft., are filled with sand. A steel cap-plate is then bolted to the upper cylinder clamp. Steel stools are then bolted on to this cap-plate, and the cross girders which carry the main girders are fixed to these stools.

The use of screw-cylinders as bridge piers has been in practice for many years, but the size of cylinder, until more recent years, had not exceeded 30 in. diameter. The limitation of the diameter of the cylinder has been due to the methods available for screwing cylinders into the river bed. The earliest bridges of screw-cylinder construction were carried out by screwing the cylinders by means of a wooden capstan with projecting radial arms, which were manhandled. Later, oxen were harnessed to the radial arms of the capstan and walked round on a suitable floating raft. Still later, these methods were superseded by the capstan being turned by means of an endless rope from a winch. These methods, however, have proved clumsy and

* Not reproduced.—Ed.

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laborious, and are quite eclipsed by the present-day methods adopted on the bridges under review.

Messrs. Braithwaite & Co., Engineers, Ltd., are the patentees of the electric capstan for pile and cylinder screwing and for many years the use of the electric capstan has been confined to solid pile work, where the diameters of the piles were 6 in. to 7 in. After experiment the use of the capstan for cylinder screwing has been perfected, and the rapidity of construction of these bridges has been made possible through the use of electric capstans of this type.

The capstan is a self-contained piece of machinery, having a steel frame on which are mounted two 15 h.p. motors acting as a couple, and with suitable reducing gear a torque of roughly 40,000 ft. lb. is produced on the capstan driving wheel and transmitted to the cylinder. When operating, the capstan sits on the top of the cylinder, the connection between the driving wheel and the cylinder of lesser diameter being made by a steel conical adapter which has four projecting lugs which fit with four corresponding sockets in the rim of the driving wheel. No other connection is made between the capstan and cylinder. The capstan is quite free to be lifted off and on to the cylinder, without having to make any disconnections whatever.

To prevent the capstan rotating round the cylinder two guy ropes secure the capstan.

At the bottom of the cylinder is an ordinary cast-iron screw blade to which the cylinder is bolted. The diameter of this screw is 5 ft. 8 in., giving a bearing area of 25 sq. ft. Neglecting skin friction on the sides of the cylinder, this gives a bearing pressure on the screw under maximum load on the bridges of 3 tons per sq. ft. It can further be safely assumed that in deep screwing the value of skin friction on the cylinder sides is roughly 2 tons per linear ft. of cylinder.

The pitch of the screw blade is nine inches, and under normal conditions each revolution of the cylinder, which takes 2 to 2½ minutes, results in a penetration of nine inches; so that a nine-foot length of cylinder can be screwed into the river bed in about fifteen minutes.

Allowances must, of course, be made for delays and difficulties in screwing in encountering a hard stratum, assembling of material and movement of plant, but, as a general idea of the rate of screwing, it may be taken that at the Coleroon, where screwing was continued to a depth of fifty feet into the river bed, two cylinders per day were screwed to their correct level, giving a rate of 100 ft. of screwing per day.

Such progress will doubtless be regarded as phenomenal. Two months to erect the substructure of a bridge of 45 spans with foundations 50 ft. into the river bed!

From the photographs showing the capstan at work, a box-like

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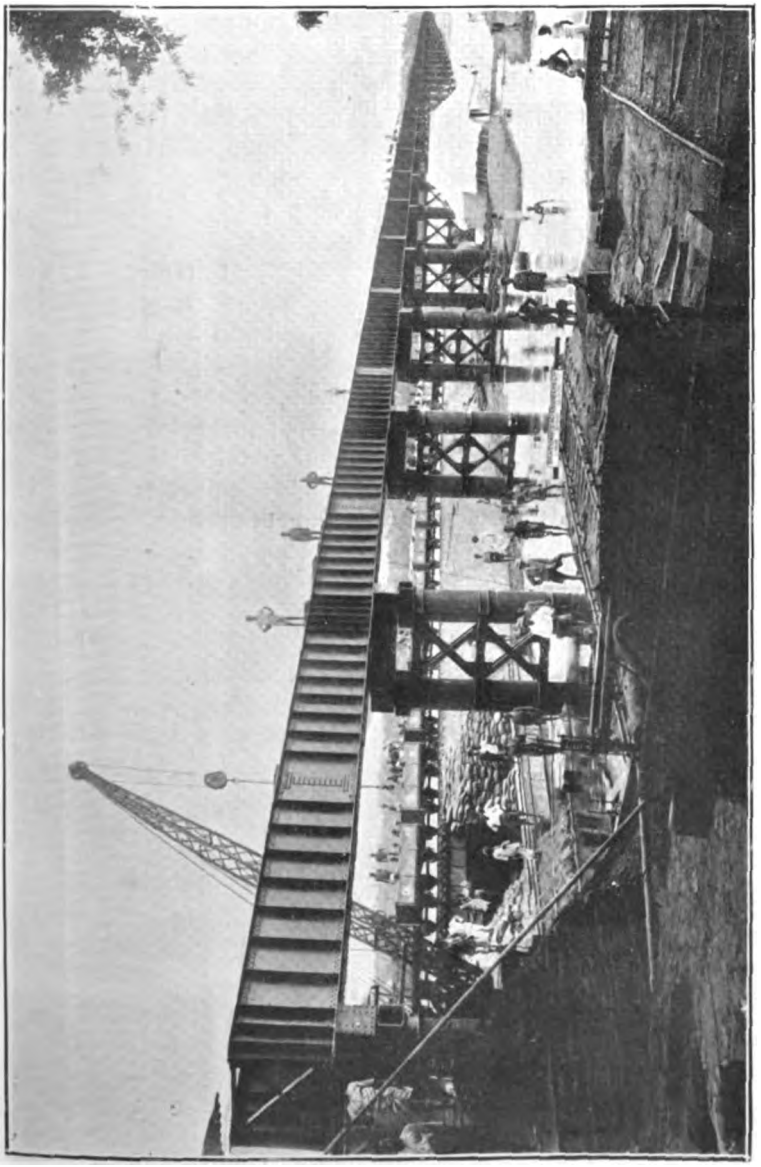
RAPID BRIDGE CONSTRUCTION.



No. 1.—Coleroon Bridge.

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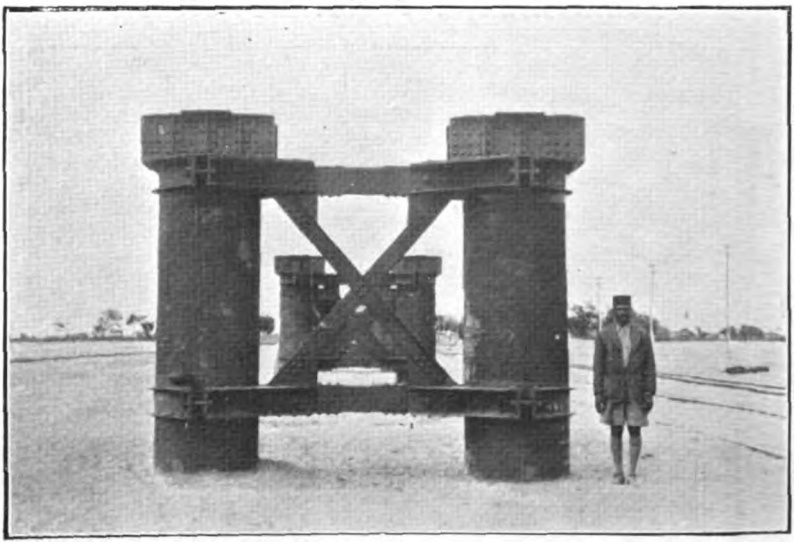
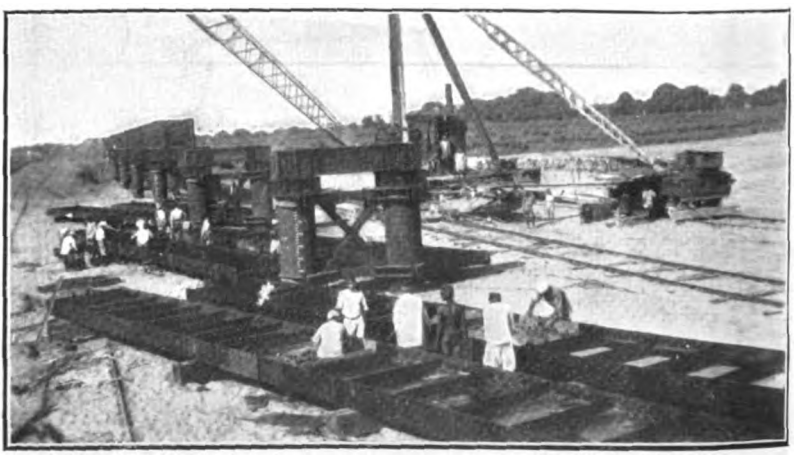


No. 2.—Pier at Ponnair.



No. 3.—Girders being assembled.

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No. 4.—Capstan being lifted on to cylinder.

No. 5.—Capstan about to commence screwing.

No. 6.—Cylinders and capstan at Ponnair.

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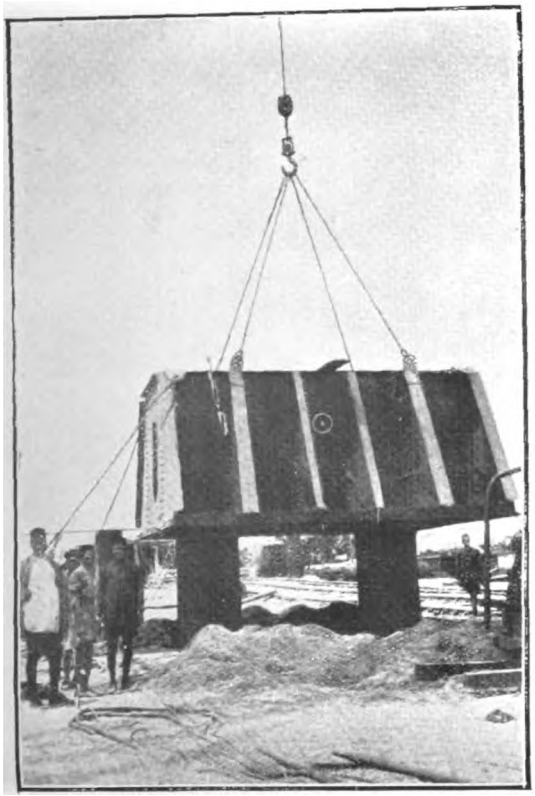
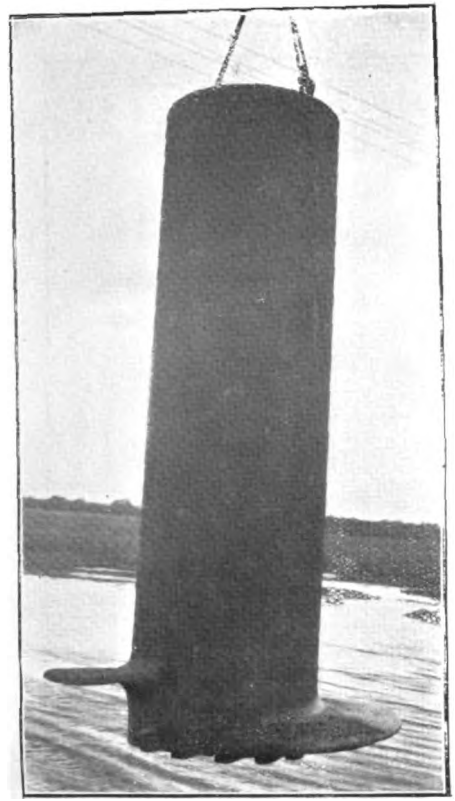
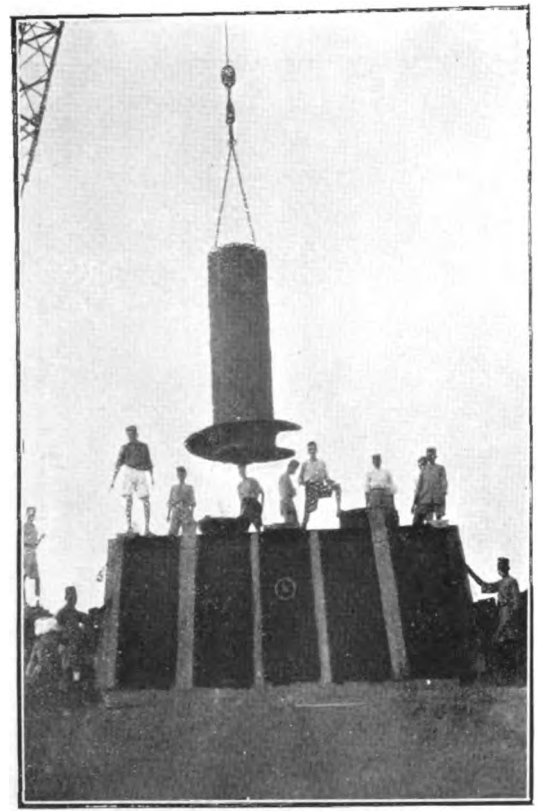


No. 7.—Cage being removed.



No. 8.—Cylinder with screw bolted to it.



No. 9.—Cylinder and screw bolted together.

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arrangement will be noticed at the base of the cylinder. This is a steel cage, the function of which is to keep the cylinders in position when they are first being screwed.

The cage, which is made out of ordinary steel plates, has two compartments, into each of which a length of cylinder with screw attached is placed.

Each compartment has a top and bottom guide, which consists of a steel frame fitting into the square compartment, with a circular opening in the centre for the cylinder and carrying rolls which lightly press against the cylinder and revolve when the cylinder is being screwed.

The centres of the circular openings of the adjacent guide frames are exactly 9 feet apart, and after the cage has been fixed in its correct position and the guide frames put in, it will be realized that the cylinders naturally fall into their correct positions, and are restrained in that position by the whole cage, which may, if necessary, be weighted down with sand or stones from the river bed.

By this means accuracy in screwing the cylinder is maintained, and only very rarely has the maximum error in the position of any one cylinder been as much as $2\frac{1}{2}$ inches, such errors being allowed for and corrected in the design of the superstructure steelwork.

When the cylinders are screwed to level, the cage is bodily lifted off after removal of the guides.

In the erection of the bridges under review, during the working season the river beds are dry, with the exception of narrow or shallow channels. The scheme for erection is therefore simplified in that direct access to the river bed is possible.

During construction, the line which is being laid from railhead for bringing out materials is usually carried right across the river bed.

Between this track and the line of the bridge a track is laid, on which one or two 5-ton loco. cranes operate for unloading plant and material and assisting in the assembling of the cylinders and steelwork.

For handling the capstan and lifting the main girders a 10-ton Scotch derrick is utilized, which is erected on the other side of the bridge, and travels on rail tracks laid in the bed of the river.

Electricity at 460 volts is generated at the site and transmitted to the capstan by a cable mounted on poles in and across the bed of the river.

All field-riveting is done pneumatically, the girders arriving in halves and being riveted together in the river bed and hoisted into position by the 10-ton derrick crane.

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TANKS AND ARMOURED CARS : THEIR USE AND THEIR ANTIDOTE.

A lecture delivered at the S.M.E., Chatham, on October 27th, 1927, by MAJOR V. V. POPE, D.S.O., M.C., R.TANK CORPS.

" Mobility implies the power to manœuvre and act with rapidity, and is the chief means of effecting surprise." *F.S.R.* II, 2, vii.

" Surprise . . . is the most effective and powerful weapon in war. Whether in attack or defence, the first thought of a commander must be to outwit his adversary." *F.S.R.* II, 2, iii.

I HAVE been asked to say something about the use of tanks and armoured cars in co-operation with other arms, and their antidote. Each of these subjects presents matters for many lectures and, in the time at my disposal, I can only hope to touch on what appear to be the main principles which should govern action in either case. I trust, therefore, that you will forgive me if I seem to skim somewhat sketchily over details.

I.—SCOPE OF LECTURE.

I propose to deal with such armoured fighting vehicles as now exist, both in type and numbers. My remarks refer, therefore, solely to the army in which such vehicles are not, numerically, the preponderant arm.

This limitation is important, since it has a direct bearing upon tactics. Tanks, not being commercial vehicles, cannot be supplied from civilian sources in large numbers during the early stages of a war, and finance is always likely to forbid the retention in peace of a large reserve which may at any moment—and must eventually—be rendered obsolete by the production of a new and better design. Similarly, though suitable chassis for use as armoured cars may be available from commercial sources, the armour will not. A commander, therefore, whose armoured resources are limited and whose powers of replacement are low, will tend to conserve those resources for the decisive blow and to " ca' canny "—as far as they are concerned—in the early stages of the campaign.

The doctrine at present laid down in *Field Service Regulations* is largely based upon a recognition of this fact. As a result, it has been somewhat severely criticized by that school of thought which prefers fancies to figures. The customary resurrection of the dead, which takes place daily during manœuvres, also tends to make us forget how few machines we really have and how difficult they will be to replace in the early days of a war. It must further be remembered that, at any one time, a proportion of our machines will be undergoing repairs or routine overhauls, and that our small

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reserve will be called upon to complete units' establishments long before battle casualties have occurred. In bringing these facts to your notice, I do not wish to deprecate an audacious policy in the use of armoured fighting vehicles—far from it, since the legitimate issue of audacity is security and surprise—but I do deprecate the tendency to expect the Royal Tank Corps to live what may be described as a Rolls Royce life on a Ford income.

In the Appendix will be found a Table showing the types of vehicles now in service, together with a rough estimate of their capabilities. All these machines, with the exception of the Crossley armoured car, are in use in this country. The Crossley is in use in India, but it is not wholly satisfactory and may be superseded by a later type of car. I do not now propose to discuss the figures given in this Table which, however, I hope may be of some use to you when you are considering problems in which the employment of armoured fighting vehicles arises.

So much by way of introduction. Now let us consider how we can best employ such machines as we may reasonably expect to possess at the outbreak of war.

II.—Elements of Offensive Action.

It will be generally agreed, I think, that to achieve decisive success in battle an arm must be in possession of three fundamental attributes:—(*a*), Striking power; (*b*), Security; (*c*), Mobility.

The claim of the armoured fighting vehicle to inclusion in an army to-day consists of the fact that, under the conditions of the modern battlefield, it combines in itself a higher degree of these three interdependent elements than does any other arm. In addition it possesses a higher proportion of security and mobility to striking power. These three elements are, as I have suggested, interdependent; but I would submit that striking power can become active only when it is based on security and mobility, for too low a degree of security tends to produce retrograde mobility and too low a degree of mobility weakens security so greatly that striking power can be easily countered.

Armour is one of the oldest devices by which man has sought to obtain security in battle, but the motive-power at his disposal has until quite recently been insufficient to enable him to retain mobility in the face of the counter-measures of his opponents, and without mobility armour becomes an encumbrance and a target rather than a protection. The internal combustion engine has given us the means of making armour mobile, and it is to this mobility that I would draw your attention.

Mobility, as *F.S.R.* tell us in the quotations at the head of this lecture, is the chief means of effecting surprise; and surprise is the

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most effective weapon in war. If, then, we can use the mobility, which the internal combustion engine has placed at our disposal, to effect surprise, we shall have made the best possible use of it. That I take to be the basic principle which should govern the employment of armoured fighting vehicles in war; the use of mobility to effect surprise: the rapier, not the battering-ram.

I would submit, moreover, that the mobility of a force does not merely imply its rapidity of physical movement but includes the rapidity of its reaction to a given situation; that is, rapidity of thought and of the translation of that thought into action. It is, for example, of little use to increase by intensive training a boxer's quickness of limb, if his processes of thought remain so slow that his brain can be "seen thinking." To take advantage of the increased physical mobility offered us by the internal-combustion engine, we must produce an increased rapidity of thought and decision on the part of all leaders. How this can be done lies outside the scope of this lecture, but it is a matter of importance which cannot be ignored.

We must then ensure that the rapid decision is transmitted rapidly. Staff duties and the Signal Service play their parts here. As regards the first, it may well be that short orders amplified by "instructions" will be found the quickest and most satisfactory method of enabling armoured fighting vehicles to execute the commander's plan. The latter presents a more serious problem. Communications, both internally and externally, are at present the "Achilles' heel" of the armoured fighting vehicle. Much experimental work is being carried out and a satisfactory solution is hoped for shortly; but, at the moment, control of an armoured force, once it has been launched into action, is practically impossible. We suffer here a serious check to our potential mobility. You will appreciate how serious this is when you consider that a machine moving at ten miles an hour covers about three hundred yards a minute. A commander will, therefore, constantly be basing his plans on situations which no longer exist unless the means of transmitting information and orders can be correspondingly accelerated. This difficulty was continuously apparent during the manœuvres on Salisbury Plain this year.

As regards physical mobility, I would point out that, as *F.S.R.* implies, it consists of two kinds: the power to act rapidly and the power to manœuvre, or what may be called intensive and extensive mobility. There are great technical difficulties in designing a machine which will combine a high degree of both characteristics, and as a result we have at present two types in service: the armoured car with a high degree of intensive mobility but with little cross-country power, and the tank with great extensive mobility but with a comparatively low maximum speed.

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III.—The Armoured Car.

The armoured car is peculiarly suited for strategic reconnaissance duties in which it forms a valuable auxiliary to the Royal Air Force, confirming and amplifying air reports. Indeed it has several advantages which the aeroplane, as yet, does not possess. It can maintain a continuous watch over a given area without relief: it can operate by night and in misty weather; it can secure identifications. It is obvious, that if full use is to be made of armoured cars in this rôle, the very closest co-operation will be required with the air. That brings us again to the problem of communications of which I have already spoken. Only the most elementary means at present exist of communicating from car to car, from car to air, and from car to headquarters, though we hope for something better shortly. There is, therefore, the more need for instructions to an armoured car commander to be explicit. It cannot be too often repeated that definite questions produce definite answers. Armoured car commanders must be told, too, the degree of importance of their mission, so that they may know whether they are to fight for their information or no. It must be remembered that the armoured car is not suited for use as an assault arm owing to its lack of manœuvrability and that normally, like all other reconnoitring troops, it will use its radius of action to obtain information rather than its striking power.

For this reason the armoured car is at a disadvantage when it is employed on tactical reconnaissance, and the fact that its employment with the advanced guard is contemplated is due, I think, to the shortage of suitable tanks. Necessity may compel such employment, but care should be taken that the cars are never closely engaged and that they are withdrawn and utilized on the flanks, or as a mobile reserve, immediately the opposition begins to stiffen. If this is not done, the casualities in cars will be out of all proportion to the results achieved by them.

But perhaps the most obviously attractive use which can be made of armoured cars is the raid. You will, however, remember the great cavalry raids of the American Civil War and how often the absence of the cavalry deprived its army of the means of obtaining information of far more importance than the transitory results obtained. We may say, therefore, that the use of armoured cars for raiding will not be justified unless the service of information is not thereby impeded. Provided that this principle is adhered to, raids may produce striking results and will certainly produce much disturbance.

The ever-increasing number of cars on the commercial market will render it easy for a guerrilla raiding force to be improvised at the very outset of a war. Such a force, even if largely unarmoured, will be capable of causing much delay and annoyance to the enemy whilst an armoured force strikes at the more important objectives,

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These objectives may be described metaphorically as the brains, eyes, nerves, feet and stomach of the enemy, care being taken always to avoid his clenched fists. Headquarters, aerodromes, signals, railways and roads, and the supply systems form, each and all, admirable objectives for such raids. The mere fact that they are threatened will cause the detachment of fighting troops from the main armies, and if they are successfully assailed, those armies will be, temporarily at all events, partially paralysed. Mechanization has made the uninterruption of the supply service more important than it has ever been before, since machines, unlike men and horses, have no better feelings to which appeal can be made and will not move when they are empty; nor can they be turned loose to feed upon the countryside. The immensity of this problem of supply and the magnitude of its importance are well exemplified by the following figures. It has been estimated that a force of five divisions with a proportion of ancillary troops, moving an average of fifty miles a day, will require 73,000 gallons of petrol daily when it is not in action. In battle the same force will require over 110,000 gallons daily. This force is not a so-called "mechanized force"; it is composed of horse, foot and guns, with a few tanks and armoured cars such as might be raised from existing armies. It is its transport, which is mechanized, that demands this immense amount of petrol; and it is its transport, of course, which will cover the daily average mileage given. The petrol-supply system of a modern army, therefore, forms a very tempting bait and we may be sure that an enterprising enemy will do more than delicately nibble at it.

In the pursuit the Armoured Car will prove invaluable, always provided that full use is made of its radius of action to produce surprise. In this connection I would again repeat that the armoured car is not an assault weapon, that its primary *rôle* is reconnaissance, and that it is, when used offensively, a "weapon of opportunity": in other words, that it obtains its demoralizing power far more by surprise than by striking power.

IV. THE SMALL TANK.

The next type of vehicle we have to consider is the small tank, the so-called "tankette." There are two types of this form of vehicle in existence at the present moment. Both of them are very much in the experimental stage, and neither of them is technically satisfactory. It is probable that their performance will be greatly improved in the near future as the result of experimental work now being undertaken.

There are various opinions as to their best use, but there can be no doubt that some such machine which is cheap to produce and maintain, and easy to handle and replace, is needed to reconnoitre for the fighting tank; to act, in fact, as its light infantry and to force the enemy

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anti-tank guns to disclose themselves. Such a machine would also be useful as cross-country transport for anti-tank guns, smoke projectors, and possibly small arms ammunition and machine guns. A more debatable view is that which holds that these small machines can be utilized in large numbers as the assaulting arm. It is difficult to see how machines of this nature can be given sufficient striking power, mobility and security to enable them to fulfil this *rôle* effectively, without immensely adding to the cost of production and maintenance—in fact without turning them into light tanks. Designers may eventually solve this problem, but I think it is safe to say that they have not done so yet, and that the present machine can be effectively used only for reconnaissance.

V. The Light Tank.

The General Staff has laid down three main governing considerations regarding the employment of the light tank. It is to be used for a decisive operation : against definite opposition : in an organized attack. Its use is, therefore, at first sight considerably restricted. There is, however, a rider : tanks may be used whenever there is a likelihood of attack by enemy tanks. As the enemy is not bound by our regulations, it is obvious that he may see fit to use his tanks in other circumstances than those envisaged therein ; and it is equally obvious that we shall have to be prepared for his doing so.

Certain conditions must, however, be fulfilled when tanks are employed if they are to have a reasonable chance of success. First, the ground over which they have to operate must be suitable. I need not describe to you the conditions under which the Third Battle of Ypres was fought. It is sufficient to say that the tanks quite literally could not pull their weight through the morass of mud that eventually engulfed most of them. That was an extreme instance, perhaps, but you may be assured that ground will always be a vital factor in any tank action.

Secondly, tanks must be employed in sufficient numbers to enable them to attack in depth with an effective reserve. What constitutes a sufficient number is still, I fear, largely a matter of individual opinion. There was a time when it was customary to call for one tank: later it was admitted that tanks should not be employed singly, and two were demanded: now it is agreed that the unit is the section of five: very soon, I trust, it will be realized that the larger the number of tanks employed on any one task, the greater will be the chances of success and the less the risk of casualties Then unsupported attacks of solitary sections will be definitely anathema.

Thirdly, tanks must not be dispersed. Prior to the German offensive in March, 1918, the greater part of the Tank Corps was scattered along the fronts likely to be attacked. Nearly all our tanks were lost without achieving anything. As Colonel Fuller has said, we were punching with our fingers extended instead of with a clenched fist.

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So much for the major considerations, now for a few minor though not less important ones. Before tanks are committed to any action, they must have information regarding the enemy they have to fight and the ground they have to traverse. To obtain this information, a reconnaissance will generally have to be made. There is a certain school of thought which maintains that preliminary reconnaissance is not necessary for a mobile arm. I fear I cannot agree. Of course, it is possible to attack without reconnaissance, just as it is possible to run a race without training, but in both cases much unnecessary strain will be put on the organism. Moreover, when co-operating with infantry, tanks will always have ample time for reconnaissance.

Having obtained his information, the tank commander is in a position to make his plan. That plan must be framed so as to enable the infantry co-operating with him to get to their appointed objectives at the appointed time; but it must be remembered that the formation's plan of attack must be framed so as to enable the tanks to secure those objectives and that everything turns upon the success or failure of the tanks, which have become definitely the assault arm on any front on which they are attacking. The tanks must, therefore, be at liberty to operate on a line of advance distinct from that of the infantry if it so suits them better, and they must receive first consideration in the disposal of artillery and machine gun support, and in the employment of smoke.

It is extremely likely that at some stage of the attack the enemy will try to restore the situation by means of an immediate counter-attack with his own tanks. It is laid down that in this eventuality all tanks will immediately abandon all other tasks to engage the enemy. Apart from the fact that such action on the part of the attacking tanks would probably leave their infantry in an extremely hazardous position, it is by no means certain that those tanks, intent as they would be on their immediate objectives, would become aware of the approach of the enemy's tanks until it was too late to take effective action. It is, therefore, now held that each attacking echelon of tanks should be followed at a convenient distance by a reserve echelon whose sole task would be to watch for and deal with such counter-attacks as might develop. Batteries of self-propelled guns might also well be employed to follow up the attack and to blind anti-tank guns with smoke as they revealed themselves.

But, above all, in any tank action let us seek to secure surprise: to use the rapier rather than the battering ram.

So much for the main principles, which, it seems to me, should govern the employment of armoured fighting vehicles. Let us now consider briefly what counter-measures we can best take against those vehicles.

VI. COUNTER-MEASURES.

Our object is to destroy, or at any rate nullify, their striking power. This we can do either by attacking their mobility and making it

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impossible for the machines to reach us, or by destroying the security which makes the effective use of their striking power possible. Of course, as I mentioned at the beginning of this lecture, mobility and security are largely interdependent, and may be expressed to a considerable extent in terms of each other; but I would suggest that, broadly speaking, the methods employed to destroy mobility will be mainly passive, whilst the attack on security will be definitely active.

The attack on mobility will be carried out by the use of obstacles, both artificial and natural. Artificial obstacles were used by the Germans in the Great War on a fairly extensive scale. Generally speaking, they were of value when they amplified natural obstacles, but were of little use when isolated. When the immense time and labour required to construct an effective obstacle is taken into consideration and a comparison is made between the radius of action of the modern armoured fighting vehicle and that of the war-time tank, I think it will be generally agreed that, except in siege operations and during position warfare, the construction of such obstacles will generally prove to be labour in vain.

I think, however, that we may expect to see an increasing use of natural obstacles, such as forests, mountains, inundations, rivers and bogs, in war. Though no natural obstacle has of itself ever yet stopped a determined attack, it does undoubtedly gain time, and so may detract from surprise: moreover it confers a great sense of security. The increased radius of action of the armoured vehicle is, however, likely to render this sense of security false, or at any rate fleeting, and I do not think that we can accept the natural obstacle as anything more than a valuable auxiliary for our means of defence.

For the attack on security we must employ destructive weapons. Small-arms fire is generally thought to be innocuous to tanks. Actually, close and intense machine-gun fire does produce "splash," which is distinctly unpleasant to the occupants of an armoured vehicle. It is not, however, even at its worst, sufficient to stop a machine, and measures are in sight whereby it will be effectually counteracted.

Though an efficient tank-mine can be, and indeed has been, easily produced, the difficulties to be overcome in making effective use of it are considerable. To lay a minefield requires time, labour and much transport; and when it is laid it is quite possible that few or no enemy machines will come near it, for lack of numbers alone will prevent more than chosen sections of the front being so protected. Moreover, the mine is a two-edged weapon. In March, 1918, we expected to be attacked by German tanks on the Fifth Army front, and a minefield composed of 60-pdr. trench mortar bombs was laid near Ronssoy. No tank attack did, in fact, take place, and the Germans advanced without disturbing the mines and, apparently, without discovering their existence. When, six months later, the wheel had swung full circle and we were attacking over the same ground, the 301st Ameri-

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can Tank Battalion struck that minefield with disastrous results. Very careful organization is, therefore, required in the laying of mines; but provided that too much reliance is not placed upon them, there can be no doubt that they do form a valuable auxiliary in anti-tank defence.

Gas, strangely enough, is comparatively ineffective against tanks, its penetrative effect into machines in no wise specially protected being in the most favourable conditions exceptionally small. There is also little difficulty in making a tank completely gas-proof, though the problem of protecting the crew against the effects of a persistent gas, such as mustard gas, when cleaning the tracks, etc., is somewhat less simple. We cannot, therefore, rely upon gas to help us much against the tank or armoured car.

To employ a field gun for anti-tank work is, to my mind, rather like using a sledge-hammer against the attacks of a swarm of hornets: the weapon is too slow and cumbersome, and the expenditure of energy is in no wise proportionate to the results achieved. Nor can the light gun be regarded as being less unsuitable. The problems of transport, concealment and ammunition supply, together with its slow time of flight, handicap it immensely in such an action. An anti-tank machine gun certainly appears to be a more formidable opponent, but there are great technical difficulties in the way of its production, and the problems of transport and ammunition supply have still to be solved.

All these weapons suffer, moreover, from a common and a very serious—indeed, I believe a vital—disability: they wholly lack mobility in the face of the enemy. Like the mine, they may be sited to cover fronts which the enemy tanks ignore, and their cumbersome and vulnerable means of transport renders it extremely unlikely that they can be moved to the fronts so threatened after action is joined. They stand stationary, therefore, to be destroyed in detail. The self-propelled gun does not suffer from this disability, though I believe that technically it is not wholly satisfactory. But what is it when all is said? A tank without the security of a tank. As it fires standing still, and must come within machine-gun range to fire at tanks with any chance of hitting them, its crew will regret that lack of armour very early in the fight. Give it that armour and it becomes a tank.

And so we come to the only solution I can offer you to the problem. To meet the tank we must produce the tank: to counter the combination of mobility, security and striking power which I have endeavoured to describe to you, we must produce a similar, and if possible a better, combination. The armoured fighting vehicle has re-introduced protected mobility into the battle, and it can be countered effectively only by protected mobility, the chief means of effecting that surprise which is the most effective weapon in war.

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APPENDIX.

Particulars and Capabilities of certain Armoured Fighting Vehicles.

Type.	Speed.		Crossing power.		Climbing power.	Circuit of action.		Armament.	Crew.	Weight fully equipped.	Engine.	Petrol capacity.
	Max.	Average.	Trench.	Water.	Slope.	Cross-country.	On road.					
Light Tanks, I and II. ...	15 m.p.h.	6–7 m.p.h.	6 ft.	3 ft.	40°	135 miles	200 miles	1 3-pdr. Q.F. gun, 2 ·303 V.M.G., 1 ·303 Hotchkiss gun.	5	11 tons (Mk. I), 12 tons (Mk. II)	90 h.p. 8 cyl. Armstrong Siddeley	90 galls.
Rolls Royce Armoured Car	50 m.p.h.	25 m.p.h.	6 ft.	1 ft. 8 in.	—	—	132 miles	1 ·303 V.M.G.	4	4 tons 2 cwt.	40/50 R.R.	22 galls.
Crossley Armoured Car	40 m.p.h.	20 m.p.h.	—	1 ft. 10 in.	—	—	120 miles	2 ·303 M.M.G.	4	4 tons 11 cwt.	40/50 Crossley	20½ galls.
Morris Martel	15 m.p.h.	11 m.p.h.	4 ft.	2 ft.	40°	40 miles	60 miles	1 light M.G.	2	2 tons 4 cwt.	16 h.p. Morris	8 galls.
Carden Loyd ...	20 m.p.h.	15 m.p.h.	3 ft.	—	45°	40 miles	80 miles	1 light M.G.	2	14 cwt.	23 h.p. Ford	8 galls.
Independent Tank ...	—	10 m.p.h.	(a)	(a)	(a)	(a)						

(a) Trials not yet completed.

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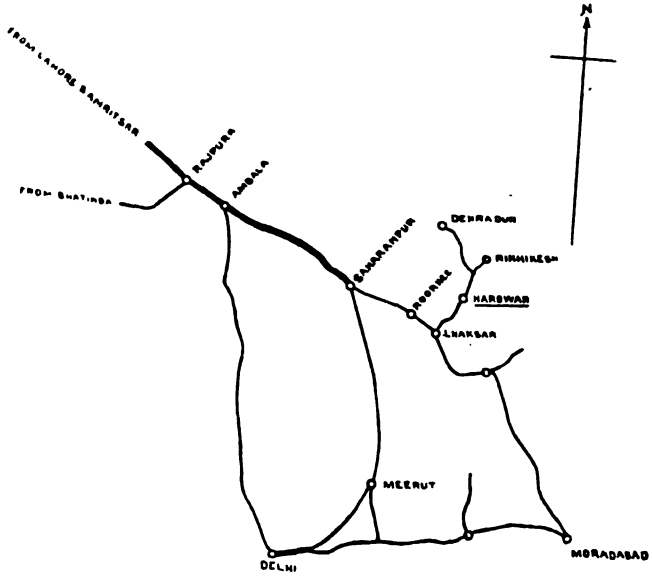
THE INCREASE OF SINGLE-LINE TRAIN CAPACITY, KUMBH MELA, HARDWAR, 1927.

By MAJOR F. H. BUDDEN, M.C., R.E.

THE problem which had to be solved was how to deal with the very heavy traffic at Hardwar during the Kumbh Mela. Hardwar is situated on a branch single line from Lhaksar to Dehra Dun, about 17 miles from Lhaksar. Lhaksar is a station on the main line of the East Indian Railway between Lucknow and Saharanpur and this main line is also a single line. (*See* sketch.)

SKETCH SHOWING RAILWAYS, HARDWAR AREA.



The Kumbh Mela occurs only once in 12 years, and although there are various ***melas*** every year and a larger ***mela*** half-way between each Kumbh Mela, yet pilgrims visiting Hardwar at any of these smaller ***melas*** do not approach the numbers visiting there for the Kumbh Mela, and so it would not pay to make the line double between Lhaksar and Hardwar merely for carrying a heavy rush of traffic for a few days in 12 years. The Kumbh Mela lasts for about six weeks, but there is one important day which fell this last time on April 13th ;

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the majority of the pilgrims who visit Hardwar stay for this day, and then they all try and get away as soon as possible. Previous to this big day there are certain less important bathing days, when there is an inward rush before the day and an outward rush after the day, but the traffic is quite easy to handle.

The following account describes what was done in March and April, 1927, to deal with the traffic at the Kumbh Mela, as it is thought that this might be of interest to officers who may have to deal with a heavy concentration of troops, etc.

Before describing the steps taken, it is necessary to explain that the majority of the traffic comes *via* Saharanpur and Lhaksar to Hardwar and only a comparatively small amount comes *via* Moradabad and Lhaksar. At Saharanpur the traffic splits up into two main directions, one towards Delhi and the other towards Amballa, Rajpura, Amritsar and Lahore. (*See* sketch.)

The traffic towards Amballa, Rajpura, Amritsar and Lahore again splits up into various directions, as a large number of passengers change at Amballa, Rajpura, etc., and leave the main line, which proceeds to Amritsar and Lahore. It was therefore essential that the sorting arrangements at Hardwar should be carefully worked out, as otherwise the sorting of pilgrims would have to be done more than once; this would create trouble all along the road, specially as the majority of the pilgrims has no idea of where they are going, except that they know the name of the station from which they started. The sections which required most careful watching were the sections

Hardwar to Lhaksar ..	..	17 miles
and Lhaksar to Saharanpur	..	33 miles,

as the traffic at Saharanpur is split up into two directions. Moreover, the line from Saharanpur towards Amballa and Lahore is a double line, and so there would be no difficulty in dealing with the number of trains which the single line section Lhaksar to Saharanpur could hand over to Saharanpur. It was not possible to have an absolutely free hand, as there already is a service of seven passenger trains in each direction between Lhaksar and Saharanpur which had to run to their fixed timings and to keep time, as otherwise they would disorganize train-running on adjacent sections. It was, however, possible to shut down all goods traffic temporarily during the outward rush, and this was done for three days before the outward rush started and as long as it continued.

In a *mela* of this importance steps had to be taken many months before the date of the *mela* to ensure that the Civil, Medical, Police and the various railway authorities worked in together.

Hardwar is a town situated between the Ganges and the Siwaliks, which are the foothills of the Himalayas, and there is a very limited space available for pilgrims. It was estimated that the maximum

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number that could possibly be taken into Hardwar was one million, and even then this would only be possible under the most careful arrangements. It can be easily understood that, when a million people visits a town with a regular population of about fifty thousand, the sanitary arrangements, the arrangements for feeding this number, etc., need the most careful thought.

Moreover, on the important day the great majority of the pilgrims wish to bathe in the holy pool, which is only reached by a number of steep steps. The traffic control in Hardwar itself on that day is one of the most difficult problems which the police of any country have to deal with, as the pilgrims start bathing at midnight and continue to bathe until all are finished. A regular circuit has to be arranged, and every pilgrim has to follow this circuit. Barriers are erected so that the pilgrims cannot rush the pool. The problem is made more difficult by the fact that there is a number of religious houses called Akharas, which bathe *en masse* and parade with a large number of elephants, camels, horses, etc., arrangements for which have to be made so that they are kept on one side until the bathing is finished and then picked up by the Akharas after the bathing. The Akharas are very jealous of each other, and there is a definite order of precedence which has to be followed, and it would be fatal if one Akhara met another Akhara on that day. Akharas have been known to sit down and refuse to move when they thought that the arrangements made on their behalf were not satisfactory, or as good as those arrangements made on behalf of other Akharas. The above will give some idea of the problems which have to be solved from a traffic control point of view, and now details of the arrangements made for carrying away by train the pilgrims after the big bathing day will be given.

The arrangements can be summarized as follows :—

(1) Increasing the capacity of the section Hardwar-Lhaksar-Saharanpur.
(2) Building an avoiding line at Lhaksar so that trains from Hardwar to Saharanpur need not pass through Lhaksar.
(3) Increasing the facilities for entraining and detraining passengers at Hardwar.
(4) The introduction of a local train control with headquarters at Hardwar.
(5) The installation of a central control at Hardwar to supervise the working at Hardwar.
(6) The provision of sufficient passenger "rakes."
(7) The provision of extra staff to deal with the increased traffic.
(8) Deciding on the method of working trains.
(9) Working out in detail the various steps necessary to enable the railway authorities to deal with the traffic.
(10) Creating a spirit of emulation amongst the staff.

Dealing with each of these in turn,

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(1) The capacity of a single-line section can be increased by introducing extra crossing stations on those sections which are long, and by providing stabling accommodation for rakes. There is a limit, however, to the number of crossing stations which can be introduced, as if the number is too large it only means that the traffic is delayed due to the time taken in starting and stopping trains. Three extra crossing stations were provided, and the limiting section was finally six miles long on a grade of 1 in 300.

(2) The building of an avoiding-line at Lhaksar was essential, as otherwise trains would have to run into Lhaksar and the engines would have to be turned and be attached to the other end of the train. This would delay working considerably.

(3) Hardwar station normally consists of a main platform and an island platform with two faces, or a total of three platforms for dealing with passengers. This is quite insufficient, and so two extra island platforms were built, and each island platform was divided into two by a palisade which ran down its centre. At the end of these four platforms were four long narrow enclosures, into which pilgrims were sorted, and as soon as a passenger rake was available the gates were opened and pilgrims were allowed to entrain. Other enclosures were also provided so that pilgrims could be sorted for trains leaving from the three main platforms.

In India there are four classes, 1st, 2nd, Inter. and 3rd, and so it was necessary to provide enclosures for the different classes, *i.e.*, one enclosure for 1st and 2nd class passengers, three enclosures for Inter. class passengers, seven enclosures for 3rd class passengers. Passengers were sorted for eight directions, and to enable the staff to deal with pilgrims for stations of which they have never heard, the tickets for each direction were superscribed with a special mark, and so all that the ticket checker's staff had to do was to make sure that only pilgrims with a certain superscription on their ticket were allowed into an enclosure marked with the same superscription. This simplified very much the instructions issued to the directing staff. A large number of pamphlets and posters were issued explaining that if a pilgrim wanted to go to Lahore he should go to a booking office marked with a red circle, and then go to an enclosure marked with the same red circle, and he would find a train which would go straight to Lahore; and the same for other stations.

At the same time, a very careful check had to be kept on the numbers booking, so that only sufficient were booked to fill the trains leaving that day. Sometimes it was necessary to close down temporarily all booking except for one or more directions in order to fill certain specials. Each special at a particular timing could be arranged for more than one direction, and it was necessary to decide in ample time for what direction each special was to go.

(4) The main line to Saharanpur and the branch line Hardwar to

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Lhaksar is normally controlled with headquarters at Moradabad, but during the *mela* a local train-control was introduced at Hardwar, which controlled the section Hardwar to Lhaksar, and Lhaksar to Saharanpur, and the control was extended to the station on the Dehra Dun side of Hardwar, so that early information could be received of any trains arriving from that direction. It was then possible to see at a glance, by going into the train-control room, the position of any train, stabled passenger-rake or engine on the section, and this simplified the orders that had to be issued.

(5) In addition to this train-control, it was necessary to have a central control regulating all operations in the Hardwar area. This control was situated in the next room to the train-control, and was connected by telephone to all the important points in the Hardwar area, such as to all platforms, booking offices, loco foremen, enquiry office, civil authorities, etc. The supervising controller in charge was responsible for co-ordinating all the work, and nothing was done without first asking his permission. This central control was absolutely essential to the success of the work, and without it it would have been impossible to handle the number of trains that were handled with ease during the outward rush.

(6) In previous Kumbh Melas sufficient passenger stock was not available, and goods stock had to be used. For this *mela* special arrangements were made, and 50 rakes of passenger stock were provided on the basis that it would take an average of two days for the turn round of each rake, and that about 24 rakes would be required daily. It must be remembered that many of the specials travelled long distances, such as 300 miles.

(7) A large number of extra staff were required in the *mela* area, and these had to be obtained from other divisions and other railways. The staff already in that area had to be tested, as although a man may be quite fit to deal with normal traffic, yet he might be totally unfit to cope with the very heavy traffic during the outward rush. It was necessary to have certain inspectors and officers at various points, so that they could take charge if anything happened which had not been allowed for.

(8) Various methods of working trains were considered, and it was found that in employing the usual methods the capacity of the single-line section would not be more than 42 trains, *i.e.*, 21 trains each way. It was accordingly decided to employ what might be called the "flow" system of working, a system which had not been employed in India before. Under this system of working, trains would run in one direction only for certain definite periods during the 24 hours, and so there would be no crossing except with regular passenger trains, and trains would run through all stations except for watering. It was found under this system that the single-line capacity of this section could be increased to 60 trains a day, in spite of the fact that

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the length of the ruling block-section was six miles on a grade of 1 in 300. It was accordingly decided to divide the 24 hours into four periods—7 to 11 hours, 11 to 15 hours, 15 to 23 hours, and 23 hours to 7 hours. Specials would be despatched one after the other from 7 to 11 hours, and again from 15 to 23 hours, while empty rakes would be brought in from 11 to 15 hours and from 23 to 7 hours.

This presupposes sufficient stabling accommodation at the starting station, but, if suitable timings are selected so that specials do not clash with the regular passenger trains, it is possible to arrange that every line holds an empty rake at the time when the first outward special of any flow is due to start. At Hardwar it was possible to hold seven empty rakes, one at each of the seven platforms, and six more in the yard.

A detailed time-table was worked out and printed, and issued to all concerned. Each loaded special and empty rake in this time-table was given a special number.

The interval between the despatch of two successive specials was 20 minutes, as this was the average time it took a special to clear the longest block section and for the Stationmaster to get line clear for the next train. This interval of 20 minutes also allowed time for placing the next empty rake at a platform after the departure of the loaded special from that platform. The actual sequence was the departure of the loaded special, the backing in of an empty rake, the return of the pilot to the next empty rake to be placed, and the attaching of the train engine from the engine shed. As many of the points were non-interlocked, the necessity for working out beforehand the correct sequence of movements can be understood, as the number of reversals of points had to be reduced to a minimum. Care was also taken that all important points were well ballasted and that the sleepers used were in good condition.

The advantages obtained through working trains on the "flow" system were :—

(1) The capacity of a single line section was increased by about 50 per cent.
(2) It was possible to work to a definite time-table for the despatch of trains. Pilgrims knew exactly at what time trains were leaving.
(3) The work at stations was decreased, as all trains ran in the same direction for certain definite periods of time, and it was not necessary to reset points, etc.
(4) The average speed of trains was very much increased, as except for watering it was not necessary for them to stop.
(5) It was possible to arrange to give definite periods off to the various members of the staff, as, when inward rakes were being brought in, there was no booking and so no work for

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the staff on the platforms or for those directing pilgrims. After the first two or three days, the work of controlling all operations in the yard became automatic, and the various members of the staff carried on with little supervision.

(6) When no trains had to be crossed, it was possible at times to join two empty rakes together and so decrease the number of movements over the block-sections. The engine of the second train merely joined on to the back of the first train and then ran through all stations.

The results obtained speak for themselves, as on the first day of the outward rush twelve inward loaded specials were received and eighteen outward loaded specials were despatched. During the next five days 135 outward loaded specials were despatched, in addition to the regular passenger trains.

(9) The correct sequence of all movements in the *mela* area was worked out in detail, and this included :—

(a) The sequence of movements in Hardwar yard and station during the outward and inward flows, so that the work entailed was reduced to a minimum. It was found that, by a change in the sequence of movements, the number of points to be set for each operation could be considerably reduced, as explained in the previous paragraph.

(b) The times at which engines should be ready at Hardwar, Lhaksar and Khan Alampura were all worked out and supplied to the loco-foremen. It was not necessary for Control to requisition for any power, and the loco-foreman knew when power would be required for each of these trains, unless he was informed that any particular special was cancelled.

(c) The return of empty rakes which had to be cancelled by Control, if one or more specials were cancelled in any of the flows, was worked out beforehand, so that there should be no possibility for mistakes.

Detailed instructions were issued to all the staff concerned, and these were explained to them, and the staff were invited to ask questions and to make suggestions after studying the instructions.

Many other special details were also carefully worked out, such as :

(i) The provision of special watering coolies at Roorkee, where all trains took water, so that the engine crew should attend to their engine while the engine was being watered. The halt at Roorkee was accordingly cut down to a minimum, and there were no delays.

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(ii) A platform assistant was detailed to see that the driver was ready to start some minutes before his booked departure, and that he left as soon as the signal was lowered and he had received line clear and the guard's signal. Under the "flow" system there is no harm in trains running before time.

(iii) Special steps had to be taken to ensure that all passenger trains (regular and special) arrived complete and required no shunting at Hardwar.

(10) There can be little doubt that, however good are the arrangements made, the results will never be good unless the staff employed really try their best, and so special steps were taken to create a spirit of emulation among the staff by visiting all stations in the *mela* area before the outward rush and telling them that the Moradabad division was out to break the record for India, by supplying good food to all the staff, and making them as comfortable as possible, etc. The results were excellent, as all previous records were easily beaten, and 60 trains a day, *i.e.*, 30 trains each way, were run on two successive days.

The above is only a short report of what was done, but it will show how careful attention to detail and the employment of the latest ideas in train-working can be used to increase temporarily the capacity of single line sections.

Many other problems had naturally to be solved, such as:

(a) Accommodation and supply of food for the staff.
(b) Sanitary arrangements, supply of food and cool water for the pilgrims.
(c) Counting, safe custody, and transfer of cash to the treasury.
(d) Cleaning and charging of passenger rakes.
(e) Inspection of pilgrims for cases of cholera, plague, smallpox, etc.
(f) Reservation of accommodation for important pilgrims visiting Hardwar.
(g) Handling of thousands of inward parcels at a station where no proper facilities exist.
(h) Arrangements for dealing with accidents blocking the running lines.

Various public bodies passed resolutions thanking the railways for the excellent arrangements which were made, and many of the pilgrims as they left thanked the officers on the spot for what they had done to help them.

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GOVERNMENT BUILDING RESEARCH STATION.

By COL. D. M. F. HOYSTED, D.S.O.

BY the courtesy of Major-General Sir Gerard Heath, K.C.M.G., C.B., D.S.O., Chairman of the Building Research Board of the Department of Scientific and Industrial Research, and by arrangements kindly made by Dr. Stradling, M.C., the Director of Building Research, a visit was paid to the Building Research Station near Watford, Herts.

The Department of Scientific and Industrial Research is an independent Government Department under the Lord President, and is charged with furthering the good of the public by means of both original and suggested research of a scientific or industrial nature. Under its inquiring purview are passed the problems concerning economy in use and manipulation of fuel, the fatigue of industrial workers and how it can be controlled and lessened, and the efficient production and employment of all manner of building materials, to quote but three of its activities. For the last-named purpose the Building Research Station came into being, first of all in temporary huts at East Acton, but now in a permanent building, as a central laboratory at which the necessary scientific work could be carried out and correlated on a wide basis, with the broad aim of affecting economy and improvement in building materials and construction.

The new organization owes much, of course, to the pioneer work of earlier Government Committees, for when the scattered results of the previous investigation were co-ordinated, in 1920, by the Building Research Board, it became obvious that, before practical problems could be tackled with any real prospect of success, much more knowledge was required of the fundamental physical and chemical properties of materials themselves, and of the basic principles underlying constructional design. This could only be secured as the result of a combined attack by architects, engineers, chemists and physicists in very definite co-operation, all pressing towards limited objectives one at a time, each of which must be secured as a reliable jumping-off point for the next assault. Owing to the urgent necessity, in those days, for very early information on special difficulties with which the building industry was beset, and which involved the wise outlay of large sums of public money by the Government, work on both general and special lines was, perforce,

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carried out side by side. For instance, attention was given to certain roofing materials, to sand-lime and concrete bricks, to the possibility of improvements in jointless flooring, and to the utilization in building of what would otherwise have been waste material. Other Government Departments, deeply implicated, all desired more help towards the immediate solution of special problems.

The necessities of post-war reconstruction brought difficulties to a head, especially in relation to national housing. The urgency and magnitude of these problems made it essential that all matters affecting methods of construction, supply of materials, organization of labour, economy and despatch in execution, should be overhauled and reconsidered, as it was patent that small savings in different directions meant considerable economy in the aggregate. Scarcity of certain materials made it imperative to test the potentialities of new kinds, or of alternative methods, of construction.

The Building Research Station worked on these lines till 1925, when it was decided to expand its sphere of activity still further. Industry as well as the Government urgently required more help towards the immediate solution, or partial solution, of special embarrassments. It was thought that in many directions sufficient advance had already been made to enable suggested new materials to be satisfactorily compared with old ones, whose qualities were well known by long experience, and to determine the value of newly proposed methods of construction. It must be realized that the building industry has been for many centuries hidebound by tradition, because of the great expense of full-scale experiment, the only kind which has been hitherto available. We use burnt clay for bricks, and lay them one upon another in the same way as the workmen of the Pharaohs of the Second Empire during the time of Moses. Masonry was not introduced into this country till the Romans came, and the art of using it died out when they left us, not to be revived till Norman times. In the past, the materials used and the methods of construction employed have, in most cases, been developed and standardized after a process of trial and error extending back through the ages. Tradition has become the controlling force and practical experience the main guide. It will thus be observed how the efficiency of this craft has depended upon the spread of knowledge gained by experience. As is well known, that spread was anything but quick or even, and the result can be seen all over the country to-day; different methods are in use in different counties not many miles apart, and local builders often do not know the underlying reasons for the application of their local processes.

Still is whole-scale experiment in full swing. Walls can be seen split and cracked from the use of unsuitable material, buildings

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covered with efflorescence and discolouration, bricks and stone disintegrating after a comparatively short exposure. Traditional habit of thought dies hard. Considering that the Great Pyramid was built some fifty centuries ago, surely we ought, by now, to be able to design for durability as well as for strength. Besides which, modern society is making demands on the building industry far beyond those which led to the evolution of our traditional materials and methods. Such demands include the vibrational stresses caused by modern traffic and modern machinery and the absolute necessity for cutting expense to the last mite. Trial and error is far too slow and costly for us; it is only by the application of up-to-date scientific methods that a satisfactory solution can be found in time to be of economical use.

One of the objects of present-day research is to replace those long and expensive full-scale tests by rapid and economical proof in the laboratory. For this purpose the Building Research Station includes engineering, chemical and physical laboratories, with a testing plant ranging from small and ingenious mirror micrometers to a five-hundred ton press. There is also a detached structure to represent a small villa, but constructed so that careful investigation can be conducted to find the best practical conditions for solving the heating and ventilating problems involved. The material of which the exterior is built in panels, can be changed at will to enable comparative tests to be made, while leaving the main skeleton intact.

The work of the Building Research Station is organized in two main divisions: general research and intelligence. The nature of the former has been indicated. Under the latter are grouped Special Investigation, Publications and the Information Bureau. The general research section is endeavouring to study the fundamental properties of building materials and to devise quick weathering tests, etc., while the special investigation section applies the information so obtained to the solution of special problems submitted to them by various enquirers. Information collected by the bureau either locally at the Station or through English and Foreign periodicals, is freely available to anyone, and unless the enquiry necessitates special experimental work, no fee is charged.

The general work of the station is published through H.M. Stationery Office in the following forms: Special Reports dealing with matters of immediate practical application and intended primarily for the industry; Bulletins or summaries of information on different aspects of the trade written for the most part in non-scientific language; Technical papers, generally of the nature of scientific memoirs; and Communications made from time to time to the technical journals and the daily Press.

The work is grouped under four main headings. Efficiency of

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Buildings from the standpoint of the User: deals with such subjects as ventilation, heating, acoustics, etc., and tests are carried out in experimental buildings erected for the purpose. A method of recording continuously the heat flow into the wall of a living-room has been devised, and it is proposed to compare the heat losses through different types of construction for different weather conditions; also different types of heating and ventilating installation are to be compared. Weathering: endeavours to find the reasons for the weathering of various materials. Why does the form of weathering in one stone differ entirely from that in another? What are the relative values of temperature, moisture, chemical and frost effects, and how can they best be resisted? Is the use of stone preservative of any value whatsoever? When the mechanism of weathering is better understood, there will be more possibility of devising reliable accelerated weathering tests upon various substances. Materials: under this heading are studied the physico-chemical properties of building materials, including cements of various kinds and the possibilities of new ones, limes and plasters, pozzolanic materials, bricks, tiles, terra-cotta, etc. Structures and Strength of Materials: this heading includes a great variety of research; both the effect of vibration on buildings and the effect of repeated stresses on building material other than metals, which are being studied elsewhere, the effect of wind-pressure upon roofs and other structures; adhesion and shear in reinforced concrete; foundations and earth-pressures, strength of brickwork and masonry, and the standardization of test methods generally.

The Director emphasized the fact that the Station exists to help the industry, but the value of its work must greatly depend upon the help given to the Station by the industry in its turn. He would appreciate any information about matters of interest or difficulty. Even puzzling minor difficulties or successes are of importance, as they may hold the clue to the solution of much larger problems. Probably at the present time as much may be learnt from failures as from successes.

The most urgent requirement of the present day is to broadcast the results obtained from known and proved successes and failures, as well as those which are the outcome of substantiated tests, so that the information may be available for everyone concerned. R.E. Officers will be particularly interested. Their work lies in scattered localities and detailed technical information on the matter in hand is seldom procurable in the time available. For us, to attain real and progressive efficiency in this branch of our activities, as in the others, it is essential that we should be able to obtain and make the fullest possible use of up-to-date scientific knowledge and of modern technical methods. For many materials and methods, that have long been hallowed by tradition, are quite incompetent

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to obtain the requisite blessing from finance to-day. D.W. Technical Instructions are published to meet this want.

A very short résumé of some of the more interesting results obtained from experiment may be of interest. It is hoped to give a fuller account of the tests in another issue.

One of the usual causes of the disintegration of external stone and brickwork in this country has been found to be the formation in or immediately below the surface of crystalline calcium sulphate (or crystals of certain other salts) caused by the action of sulphur acids dissolved in rain-water on the lime and lime salts already present. The discovery of this phenomenon has two wide-reaching results and bears an important message for all who are charged with the maintenance of buildings.

When the comparatively soft lime mortar in a joint falls out, it is customary to rake out the joint and repoint it in a hard cement. The efflux of the discharge which caused the trouble is thus diverted to the brick or stone, with the result that the fabric of which the building is constructed is forced to flake away at the side of the joints instead. As long as lime or other salts soluble in rain-water impregnate the material, the pointing should be looked upon as the fuse of an electric circuit, the function of which is to preserve the more valuable part of the installation. Any repointing should rather be done in lime mortar; that is, the fuse must be replaced.

As far as is known at present, the best way to preserve brick or stone is to wash it with the fire hose, twice or three times a year. This can often be arranged in conjunction with the usual fire-alarm tests without further labour or expense. Not till all the deleterious salts have been washed out should building material be covered up with cement.

In the construction of reinforced concrete the cement tends to contract when drying out, while the steel members resist this tendency. The more quickly cement is made to dry, the greater this force of contraction. So that in the case of very rapid hardening cements, the resulting state of unstable equilibrium of the mass is ominous. So much so, that under certain circumstances a shock or concussion might disintegrate it. This might have considerable effect in the case of piles or reinforced concrete work in fortifications in time of war. To reduce the internal stresses, concrete should be allowed to dry slowly and as far as possible in contact with water.

A more detailed account of the activities of the Station are shown below.

Efficiency of Buildings from the standpoint of the User.

1. Acoustics of buildings.

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2. (*a*) Solar radiation on thin roofing materials.
   (*b*) Heat insulating properties of materials and construction.
   (*c*) Heating and ventilation.
3. Absorption of moisture by internal wall coverings.
4. Fire-resistant construction.

Weathering.

1. Development of accelerated weathering tests.
2. Movements of materials due to :—
   (*a*) Temperature changes.
   (*b*) Moisture changes.
3. Preservation of stonework.

Materials.

1. Physico-chemical phenomenon of building materials, including study of possible gel structure.
2. Constitution, micro-structure and correlation with physical properties of cements.
   (*a*) High alumina cements.
   (*b*) Portland cements.
   (*c*) High magnesia cements.
   (*d*) Portland blast-furnace cement.
3. Limes and plasters.
   (*a*) Classification.
   (*b*) Physical and chemical properties.
4. Pozzolanic materials.
5. Paints.
6. Bricks and terra-cotta.

Structure and Strength of Materials.

1. Vibrations in buildings.
2. Fatigue in building materials (other than metals).
3. Effect of wind-pressure on structures (in conjunction with Engineering Research Board).
4. Physical changes due to temperature and moisture changes.
5. Reinforced concrete—shear and adhesion.
6. Special structures—domes and special roof trusses.
7. Standardization of test methods.
8. Foundation and earth-pressures.
9. Reinforced concrete slabs.
10. Strength of brickwork and masonry.
11. Reinforced concrete columns.

General Laboratory Work.

Collection of data on the properties of materials and their method of manufacture.

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LIST OF PUBLICATIONS ISSUED OR IN PREPARATION.

"Experimental Cottages." A report on the work of the Department at Amesbury, Wiltshire, by W. R. Jaggard, F.R.I.B.A. (1921)

Special Reports:—

No. 1. "Sand-lime and other Concrete Bricks," by H. O. Weller, B.SC., M.INST.C.E. .. .. (1921)
No. 2. "Experiments on Floors." .. .. (1921)
No. 3. "The Stability of Thin Walls." .. .. .. (1921)
No. 4. "The Transmission of Heat and Gases through, and the Condensation of Moisture on, Wall Materials." .. (1921)
No. 5. "Building in Cob and Pisé de Terre." .. .. (1922)
No. 6. "Graphical Cost Analysis of Cottage Building." .. (1922)
No. 7. "Heat Transmission through Walls, Concretes and Plasters." Experiments carried out at the National Physical Laboratory, by Ezer Griffiths, D.SC. .. .. .. (1923)
No. 8. "Fire Resistant Construction," by R. E. Stradling, M.C., D.SC., PH.D., A.M.INST.C.E., and F. L. Brady, M.SC., A.I.C.
No. 9. "Lime and Lime Mortars," by A. D. Cowper, M.SC., A.I.C.
No. 10. "Breeze, Slags and Clinkers as aggregates in Concrete," by F. M. Lea, M.SC.

Bulletins:—

No. 1. "Jointless (Magnesium Oxychloride) Floors," by P. W. Barnett, A.R.I.B.A., and B. Bakewell, M.A. .. .. (1925)

Technical Papers:—

No. 1. "The Stress Analysis of Bow Girders." .. .. (1926)
No. 2. "Primary Stresses in Timber Roofs (with special reference to curved bracing members)," by A. J. Sutton Pippard, M.B.E., D.SC., and W. H. Glanville, B.SC., A.M.INST.C.E.
No. 3. "Permeability of Portland Cement Concrete," by W. H. Glanville, B.SC., A.M.INST.C.E.
No. 4. "The Determination of Free Lime in Hydraulic Cement," by F. L. Brady, M.SC., A.I.C., and F. J. McConnell.
No. 5. "The Consistence of Cement Pastes, Mortars and Concrete," by N. Davey, B.SC. A.M.INST.C.E

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THE ORIGIN OF TUNNELLING COMPANIES, R.E.

A Speech by LIEUT.-COL. SIR JOHN NORTON-GRIFFITHS, BART., K.C.B., D.S.O., *at the Tunnellers' Dinner.*

IT gives me very great pleasure, not only to be your guest to-night, but to have an opportunity of thanking my old friend, General Harvey, for the generous terms in which he referred to me at your last Annual Dinner. Owing to my absence abroad it was impossible for me to accept your last year's invitation, but I read of what took place then, with keen interest, from your annual record, and it made me still more disappointed that I had been unable to attend.

It has been suggested that I might give you this evening the very early history and the origin of Tunnelling Companies, R.E., so that this can perhaps be placed on the records of the Association.

During the early days of the War, I was eating my heart out with the Regiment I had been permitted to raise by Lord Kitchener, the 2nd King Edward's Horse, longing to get to France and seeing no prospect of so doing. In thinking over the position that was taken up so early in the war, of the opposing trenches being so near together, as an old miner the idea of undermining and blowing up the enemy occurred to me. As early as November, 1914, I sent in a scheme to the War Office and begged permission to be allowed to take out a handful of men, whom I described as "Moles," and start, but although the scheme was listened to sympathetically, and, indeed, sent out for approval to France, it went no further, until early in February, 1915, I got a telegram to report immediately to Lord Kitchener, and well do I remember that interview. Alone in his room at the War Office, he showed me the urgent despatches which had been coming from Lord French, to the effect that unless some means could be found of checking the mining efforts of the Germans, he (Lord French) would probably have to withdraw certain sectors of the line. Lord Kitchener, to whom I had had the honour of being known, both in the South African campaign and in Egypt, asked me to amplify my suggested mining scheme. Just before this interview the Boche, it will be remembered, had given us a nasty blow at Ypres, had lifted, almost *en bloc*, some of the 16th Lancers in a dug-out near Hill 60, and had buried some 22 or more men at Givenchy, in addition to several minor mines they had sprung on our front trenches.

To his demand I replied, the only thing I could suggest, subject to examination of the ground, would be to use "Moles"; when he

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said, "What on earth are 'Moles'?" I said "Clay-kickers, or workers on the cross," using a North Country expression for this class of small tunnel mining. As his patience showed signs of giving way, I then proceeded to demonstrate, with the fire shovel from the War Office grate, and showed him, lying on the floor, what a clay-kicker really was, and what a small hole he could work in, with the result that he turned around and said, "Get 10,000 immediately." I replied that I did not think there were 10,000 in the British Isles, and that it would be necessary to examine the ground before one could ascertain whether this form of mining were possible. The result was, I was off that very night to France, with two of my expert underground tunnellers, who were then employed on important underground works at Manchester for that Corporation. I found, on arrival, that we could at once begin operations to answer the Hill 60 attack, and proceeded, the same day, to Givenchy, where, on hearing a cry of "Hello! there's Empire Jack," I found in the trenches some of my old Wednesbury friends in the Wednesbury Company of the Staffordshire Regiment, many of whom were miners themselves and were accustomed to mining in the narrow seams which exist in some of the Staffordshire coal-fields. The consequence was that I reported to General (now Lord) Horne, Commanding the 2nd Division, to whom I had been sent, that, with the help of the men on the spot, under, I think, Captain Morgan, of the Staffordshire Regiment, also a mining engineer, they could devise a means of defending themselves while I returned to report to Headquarters and the War Office.

I reported back that same night and saw Lord French, explained to him what the position appeared to be, crossed that night, and reported next morning to Lord Kitchener and laid before him what I thought was possible, and that the position was more than serious for the poor devils doing the dirty work in the trenches, for you could not expect Tommy to be shot at from the surface, boofed at from above, and blown to Hell from below. This was on Tuesday, February 15th, and the first bunch of clay-kickers was in the trenches on the following Friday, and in a very short time, you will all remember, we gave them a jolly good answer at Hill 60.

Resulting upon this, almost unlimited powers were given me to rush men out and begin work while the powers-that-be were thinking out the necessary regulations to govern tunnel companies, then described as "Moles" for the purpose of secrecy, which ultimately became part of the Book of Regulations. Well do I remember the early stages, when men were rushed to Chatham, put into kit, and, as under the regulations no man could leave this country without carrying a rifle and 150 rounds of ammunition, we experienced something approaching terror as we wondered whether each man would be shooting the other before we got them to the other side, when we promptly disarmed them—anyhow as far as ammunition went. Well

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do we all recollect some of those splendid fellows rushed into the trenches within three or four days from the date it had first been suggested that they should join the Tunnelling Companies; hurried up in special lorries awaiting them at Boulogne, with no rest, right in the very fiercest part of the battle front, without any training whatsoever, many of them never having held a rifle in their hands before. One old muck-shifter of mine remarked, "The sooner I get underground the safer I shall be." The pick of the British mining industry threw themselves heart and soul into the work, showing, in record time, that for mining progress and speed, no one could touch a Britisher, or even equal him at that game.

At that time there was no question of how many: "Get as many as you can." We started by forming one company after the other as circumstances demanded. But you all know the ultimate result, that in a very few months we had raised 35,000 miners, who were embodied in Tunnelling Companies, beginning at the 170th Tunnelling Company R.E., up to the 215th, I think, to which must be added the Tunnelling Companies later brought over by the Canadians, Australians and New Zealanders, and also the South African unit. To obtain this I corralled the assistance of Sir John Cadman; we searched England, Scotland and Wales, addressed meetings and mine-owners, and called for volunteers at a rate of so many from each mining centre. We then had to search the mine rescue stations for Proto sets, and other life-saving devices. One thing after the other was developed, including listening-schools behind the trenches, and the finding of some explosive somewhere between the local effect of the high explosive and the slower black powder, resulting in our excellent old pal, ammonal, which gave such a good account of itself.

It is amusing now to remember that in this capacity we sought the assistance of the Metropolitan Water Board, and borrowed the listening sticks they used for tracing leaking water-mains. All these different phases we went through, culminating in one of the most efficient and up-to-date units in the British Army, who were able to hear Mr. Boche scratching his head when he was wondering if he was going to bury us alive in our lines.

The records of the first few months of those hurriedly raised units can be taken as a world's record in footage of a necessity of a defensive nature. None of you here will ever forget the heroism of many of our old comrades who were buried in their efforts to counter the German underground attack on our trenches, and the many lone hand-to-hand fights to the death which took place in the dark between tunneller and Boche miner, when occasionally we broke into their tunnels when counter-mining. Many incidents would thrill anyone to the marrow when recalling the extraordinary and unexampled individual bravery and energy which took place in connection with this underground work.

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But my desire to-night is more to tell you the history of the Messines Ridge effort, culminating, as it did, in the greatest mining effort in the history of the world. Directly the position our troops occupied under the Ridge was realised, and as soon as we gleaned that the underlying strata was indeed blue London clay, it became obvious that it was a simple, although rather lengthy job, to run a system of deep mines to undermine the whole ridge. You all know the result. But may I tell you of the difficulties we encountered at the inception of the idea? The order came that our tunnelling was to be of a defensive and not offensive nature, and when we had decided that the deep mining was a feasible proposition, it took nearly six months to get the necessary authority to put the work in hand. Both G.H.Q. and the Army Council at that time were averse to adding another spoke to a well-filled wheel if it could possibly be avoided, and, although it was suggested in July, 1915, authority was not obtained until January, 1916, when my old chief, that great man General George Fowke, took me, with the then "Colonel" Harvey, for an interview with the five Army Commanders, upon which interview we considered so many lives depended. At that interview the scheme was unfolded to them, and I do not think it would ever have been undertaken had I not then said we could guarantee that if our mining system were completed—and we saw no reason why it should not be—it would save the lives of at least 10,000 men and that when the day of the attack came the Army could walk to the top, smoking their pipes. I well remember these words being used, for we all knew, from the attack which had already been made, the impossibility of a frontal attack on the Ridge being successful unless we were permitted to co-operate by undertaking this work. It was explained that the intention was, not to "blow out" but to earthquake the whole of the Ridge, which, owing to the fact that the sand hills were virtually one big hill of sand, sitting on blue clay, gave us a splendid opportunity of achieving success in this direction, and we guaranteed not a single German machine-gun, of the thousands that existed on the Ridge at the time, would bark on the day of the attack, if that attack were preceded by our little earthquake.

The answer was still in the negative, but late that night, my chief, General Fowke, informed me that authority had been given and we could proceed with the laying-out of this work. The sites of the two main shafts were selected, ringed in and marked "Water wells—no admittance," and, in this connection, it will be recollected that the season had been a very dry one and that there had been difficulty in getting good water, so it was an appropriate name to hide up our efforts. I well remember this period, because our old friend, General Swinton, was at the same time fighting just as strenuously to get authority to develop the tanks. We used to put our heads together in secret and wonder how we could persuade the Powers-that-be to get

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the necessary authority for him to do what he wanted and for us to do what we wanted.

Great anxiety was constantly expressed by the Army Commanders as to what would happen when we let off such a vast quantity of explosives, and so much uncertainty existed in the minds of the higher officials that a consultation took place at the War Office between two or three of the leading members of the Institution of Civil Engineers, with a view to ascertaining how close the troops could be when the mines were ultimately let loose. Owing to my being sent off on another mission to Rumania, I had not the opportunity of seeing the result of this splendid effort, but I was profoundly touched when, on my return from Rumania, I had an invitation extended to me to go and see the result. All we said had come true. There was not the slightest doubt in anyone's mind that the frontal attack without the mines would have been an absolute failure, and would have cost, not 10,000, but 50,000 men, while the attack, preceded by this stupendous artificial earthquake, which shook the Ridge from end to end, and which made the pill-boxes topple over at all angles, supported by the terrific bombardment of our guns, which had been going incessantly, enabled the Army, as we had promised, to walk to the top of the Ridge in comparative safety.

The end of this big mining effort we all know. In the Plugg Street section, in the southern end of the Ridge, a group of mines still in the clay belt were held in reserve as a surprise packet for any counter-attack which it was thought the enemy might make. But the earthquake effect, as far as mining went, was such an indication of goodwill that the contemplated counter-attack never took place, and tons of ammonal had to be de-mined.

The work of Tunnelling Companies, being responsible for the safety underground of the whole British front, became of such stupendous importance that our Engineer-in-Chief, that brilliant soldier General Sir George Fowke, after many conferences decided that it was necessary to have its own General Commanding, with necessary staff at G.H.Q., which resulted in the selection of Colonel Harvey as your G.O.C., with that brilliant mining engineer and born soldier, Captain Stokes, and we all know what magnificent work they did, and the assistance and help they gave to all you good tunnellers who had to do the actual work in the trenches.

Reverting to Messines, it is interesting to recall that this enormous mining undertaking on the Ridge, although only begun in February, was ready for the big offensive intended for July, 1916, but, owing to the developments on the Somme, it had to be postponed for a year. Through the whole of that year this huge system of underground mines lay, fully charged and bottled up, and some of us will remember, when the shafts were boarded up and camouflaged purposely to resemble dug-outs, the Boche raided a portion of our trenches, Plugg Street

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end, and actually occupied one of the dug-outs for some days, not knowing that underneath them was the main shaft of one of the most powerfully charged group of mines in the world. However, before they discovered our secret, they were driven out in a counter-attack.

It may not be out of place to recall one of the early incidents near St. Eloi, in what were then well known as the E. and F. trenches. None of them communicated in those days and, when we were trying to pole down through running sand, which sat on top of the clay belt, as silently as we could, in one place, not 70 metres distant, came a German voice, in perfect English, telling us that it was useless to try, as they had done so and failed. One of the best bluffs we put up in the very early stages, when any noise of a tapping nature was taken to be an indication that the Germans were undermining the trenches we were occupying, was to hurriedly sink a little pit, run a heading in, about 20 or 30 feet, wedge up a cross-bar, and hang on it a pick-head or shaft with a bit of string attached to the top, this being pulled from the surface at odd moments against a board jammed in the face, and would cause the Boche to imagine that we were also mining, which resulted in putting the wind up Master Boche and in many of their mines being blown short.

I could give you case after case and story after story of individual bravery and resource, equal to anything in the Service, if time permitted, but I must just remind you of a splendid R.E. officer, of the name of Colonel Griffith, who was C.R.E. of one of the 5th Division units; in answer to an urgent telegram "Send Griffith enemy mining" (meaning me)—he proceeded, with two miners who had just arrived from England, to a dug-out on the front line. It was said they had had, perhaps, a wee drop too much, but after listening very carefully with their ears to the ground, they reported to Colonel Griffith, who was slightly deaf, that the noise must be the result of two male rats quarrelling over a lady rat—*Cherchez la femme!*

Before I sit down, there is one thing I should like to refer to.

I don't know if any of you here to-night have been to Edinburgh and seen the Scottish War Memorial. It is an immensely impressive and moving edifice, but what particularly appealed to me was, that when the suggestion was made that "the humble beasts who also served and died" should be commemorated, a tablet was chosen, depicting our little friends the white mice and the canaries, and has been beautifully carved on one of the pillars of the Chapel, and is entitled "The Tunneller's Friends." That must appeal to all of us, and many, I am sure, will make a special pilgrimage to Edinburgh to pay their tribute of affection to the little beasts who helped you in the early stages of difficulty and danger.

This has been a great evening for me, and recalls one of the happiest periods of my life, when I had the honour of being one of you. Here's to the Tunnellers!

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ANTI-TANK MINES.

By LIEUT. M. O. COLLINS, R.E.

IN modern warfare there are at present only two defensive weapons against a Mechanized Force :—

The Anti-Tank Guns,
The Anti-Tank Mines.

The latter are at present under R.E. control and so, perhaps, a few theories on their employment may not be out of place.

The employment of Anti-Tank Mines falls naturally into two categories :—

(*a*) Permanent Defences.
(*b*) Mobile Warfare.

(*a*) PERMANENT DEFENCES.

Under this category fall all forms of field fortification, in the preparation of which reserves of time and material are available. The mines can be laid in two definite ways :—

as a single obstacle, or as tactical fields to force the tanks along definite lines of approach, which will be covered by Anti-Tank Guns.

If it is required to render a large area of ground impassable to tanks it is unnecessary to cover the whole of it with mines. Four rows of mines around the perimeter will be sufficient to neutralize the area.

When the fields have been laid, large-scale maps will have to be produced showing the exact location of the fields.

To prevent the possibility of these maps passing into enemy hands, they should not be distributed to Units. Tracks, which could easily be closed, and changed, should be wired in across the fields.

(*b*) MOBILE WARFARE.

This category is, perhaps, the more important and certainly presents the more complicated problem of the two.

The more that armies become mechanized, the more unlikely does position warfare become, as the mobility and fighting power of a mechanized force prevents anything like a permanent defensive position being evolved in the face of the enemy.

The problem divides itself naturally into three parts :—

(i) The Organization and Distribution of Anti-Tank Mines.
(ii) The method of laying and the best position for fields.
(iii) The recording of fields and the transmission of their position to units concerned.

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(i) *Organization and Distribution.*

The present policy is to carry a number of these mines with the Field Park Company, and these would be laid by the R.E. with the assistance of Infantry working parties. This would be suitable for stabilized warfare, but much too slow for mobile operations; in the latter case mines have to be laid at a moment's notice to block a defile, and a section in a Field Company has to be kept ready for this work, and it is often unable to obtain a working party in sufficient time to provide the necessary labour. Defence against armoured fighting vehicles (A.F.V.) is so important that it is suggested that a separate unit be formed for this work.

For preliminary trials this unit might take the form of an A.T.M. section for each Brigade composed of R.E. and Infantry personnel.

It is assumed that each section would have up to 1,250 mines; then, according to the organization given below, the personnel would consist of 2 officers and 28 other ranks, and the transport would consist of 9 motor-driven vehicles.

ORGANIZATION OF AN A.T.M. SECTION.

Vehicle	Officers	N.C.O.s	Drivers	Men	Mines	Remarks
H.Q. Sub-section—						
1 H.Q. lorry ...	1	1	1	4	50	
1 lorry		1	1	3		For record-
2 lorries		2	2	8	600	ing.
1 motor-cycle ...			1			As D.R.
No. 1 Sub-section—						
2 lorries	1	2	2	8	600	
2 motor-cycles ...			2			As D.R.s.
	2	6	9	23	1250	

The vehicles designated as lorries would be six-wheelers, if possible. The H.Q. car would of necessity have to be a six-wheeler.

The lorry for recording the fields would be provided with tables and large-scale maps, and would be under the charge of the senior N.C.O.

One section would be attached to each Brigade H.Q. and one to each Division H.Q.

The Division Section would have an officer in charge of the recording lorry in addition.

The *modus operandi* of these sections will be described later.

(ii) *Laying the Fields.*

At this stage it is, perhaps, advisable to consider the area a Brigade Section would be able to cover with its mines.

When laid in a single row, they should be 1 ft. apart. Thus 300

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mines are required to every 100 yds. of length, or to neutralize an area 100 yds. square, 1,200 mines are required.

This shows that Brigade Sections can only cover a very small area without a further supply of mines from Corps reserve, and the more mobile the operations, the more uncertain and difficult will be the supply of mines from these reserves.

Unless the laying of fields is vitally necessary, a more economical method of laying mines should be adopted.

The number of mines required to block a road or track is between 10 and 20. Thus tracks can be blocked in fairly large numbers, and the Brigade Section can still be left with sufficient mines to deal with an emergency.

The modern A.F.V., although capable of moving across country, is more mobile on roads or tracks, and tends to keep to these forms of approach until its proximity to the enemy forces it to deploy across country. If all important roads or tracks around a moving or stationary Brigade, at some distance from the Brigade, are blocked, it will greatly reduce the attacking speed of any opposing A.F.V.s.

Unlike other forms of road block, mines do not need to be covered by fire, as the less they are brought to the notice of the enemy the more likely are they to perform their *rôle*. This is to disable an A.F.V. in the road and to force the remainder of the enemy either to move across country, or to make a circuit round the block, thus delaying them and allowing the Brigade sufficient warning of their approach.

It is argued that it is wasteful to employ mines on these road blocks, when trees and farm carts could be utilized. A farm cart, however, is not much of a block against a tank, and, to render the road impassable to all forms of A.F.V., trees have to be felled across the road.

To fell trees across the road, time, labour and tools are required, and these tools are only obtainable from Battalion or Brigade reserves.

In order to block the more obvious approaches in this way, large numbers of Sappers would probably have to be detached.

Thus to economize mines by not using them in road blocks would in general be false economy, as it would entail the distribution of Sappers on the outskirts of a Brigade, for whom there is work of more vital necessity.

The method of employing a Brigade Section when the Brigade was either on the move or stationary would be as follows.

No. 1 Sub-section would be sent out to block all obvious tank approaches, and, where possible, to block them in defiles.

The H.Q. Sub-section would remain at Brigade H.Q.

When air report, or other information, of an impending attack by hostile A.F.V. was received, the H.Q. lorry would proceed as fast as possible to the line of approach of the attack, followed more slowly

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by one or more of the lorries of the H.Q. Sub-section. When it arrived, it would lay mines to limit the lines of advance of the enemy A.F.V., so as to bring them under the fire of Anti-Tank Guns.

It is quite possible to construct a chute to lay mines from a moving vehicle.

These mines are not buried, but, if the grass or undergrowth is more than six inches high, they are not visible until the tank is actually on them.

If the tank succeeds in stopping before reaching the mines, one of the crew will have to get out to remove them, a difficult and dangerous feat if the field is under fire.

Moreover, mines laid in this way can be quickly collected when they are no longer required.

(iii) *Recording the Fields.*

It is unlikely in future wars that Units will be issued with a map of scale larger than 1 in. to the mile, and although A.T.M. Sections themselves may have larger scale maps, fields should be laid, where possible, at places easily recognizable on a 1 in. map.

The places most easily recognizable on a 1 in. map are defiles or road junctions.

It is impossible to lay a field in a road or track so that it is invisible.

If a Unit requires to move over a field so laid, its position can be indicated within 100 yds. on a 1 in. map, and a few moments' careful search should be sufficient to locate the field.

The usual procedure in recording fields would be as follows:—

The approximate positions of fields to be laid would be given to Sub-sections before they left Brigade H.Q. These approximate positions would be recorded in the recording lorry.

When Sub-sections were laying fields, they would inform local Unit Commanders of their position. If other positions were found suitable for fields, they would be reported to Brigade H.Q. as soon as possible by D.R.

As soon as all fields were laid, Brigade H.Q. would be informed of their exact positions by D.R.

Brigade H.Q. would be responsible for transmitting the positions of all fields, laid or being laid, to Division H.Q.

To prevent delay, Brigade and Division recording lorries will have lists of minefields prepared, giving the exact position of fields laid, and the approximate position of fields being laid, so that when a Unit Commander asked for a position of fields he would be handed a list and he could cross off all fields that would not affect him, in order that he might issue lists to subordinate Commanders.

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THE LIFE-WORK OF THE RT. HON. SIR GEORGE TAUBMAN-GOLDIE, K.C.M.G., P.C.

By LT.-COL. P. H. KEALY, R.E. (*retired*).

THERE died on August 20th, 1925, at the age of 79, a great administrator and Empire builder, Sir George Goldie. He was the maker of Nigeria, and, as he started his career in the Royal Engineers, some account of the work he accomplished should be of special interest to the Corps.

George Dashwood Taubman-Goldie was a Manxman, the youngest son of Lieut.-Colonel J. T. Goldie Taubman, Scots Guards, Speaker of the House of Keys, and was born in the Isle of Man on May 20th, 1846. He was intended for the Army, and after passing through the Shop, obtained a commission in the Royal Engineers on 22nd December, 1865, which he resigned on 24th July, 1867.

After some years of African travel, Goldie first visited in 1877 what is now Nigeria, a vast territory of some 500,000 square miles, the bringing of which under civilized rule and its eventual inclusion in the British Empire was to form Sir George Goldie's life-work.

He visited the country with his brother, intending to ascend the Benue (the great eastern tributary of the Niger) to Yola, and thence cross to the valley of the Upper Nile, where they had previously travelled together. Various events prevented the journey being carried through, but it was at this time that Goldie conceived the idea of bringing the region now known as Nigeria under the sway of Great Britain. For the next twenty-three years all his endeavours and foresight were directed to its accomplishment, which was finally brought about in 1900.

During the seventeenth and eighteenth centuries there had been much speculation as to the course of the Niger. Traditions of a great river flowing from west to east had come down from Roman times, and it was generally supposed to discharge into a great lake or to join the waters of the Upper Nile. Or alternatively it was believed to flow westwards from the Nile, and to enter the Atlantic by two mouths, the Senegal and the Gambia.

Many unsuccessful attempts were made in the eighteenth century to reach the Niger by expeditions from the Guinea Coast, from the north across the Sahara, and from the Nile basin. In 1793, the

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African Association sent out Mungo Park, who started from Gambia, and reached Sego on the Upper Niger on July 20th, 1796. He was the first recorded European to see the upper reaches of the Niger. After travelling down the river a short way as far as Silla, he made his way back, and reached the Upper Gambia, after incredible hardships, on June 10th, 1797.

Though the Niger had actually been seen, its further course was still a question of guesswork, and Mungo Park considered the river found its outlet to the sea as the Congo. He was anxious to trace the further course of the Niger, and in 1805 left the Upper Gambia again, with a better-equipped expedition. He eventually reached the Busa rapids on the Lower Niger, at no great distance from the sea, having descended the river from Sansanding in a boat built by himself and other members of the expedition. Here he was attacked by armed natives, and he and the other remaining Europeans were drowned in 1806. The fate of the expedition was not known in England till 1811.

In 1815, the Government sent an expedition under Captain Tuckey to the mouth of the Congo, to sail up the river, and try to reach the Niger or Lake Chad. This expedition only reached 160 miles from the sea, and accomplished nothing.

Owing to our annexation of Malta, and the information gained from our Consuls in Tripoli, the next attempts were made across the Sahara. The first one, in 1818, came to an end with the death of its leader, Mr. Ritchie. In 1822, a second attempt was made by Dr. Oudney, Lieut. Hugh Clapperton, R.N., and Lieut. Dixon Denham, of the British Army. The expedition reached Lake Chad, and did a lot of exploration in Bornu, but failed to clear up the Niger mystery. Clapperton led another expedition in 1825, having as his servant one Richard Lander, who was the man who eventually solved the Niger problem. This expedition did a lot of exploration, but got no further down the Niger than Busa, where Mungo Park had met his death in 1806. In 1830, Richard Lander, " ex-page-boy, valet and footman," aged 25, and his brother John, aged 23, were sent out by the British Government, and landed at Badagri, on the West Coast, near Lagos. From here they made their way northwards till they reached the Niger about Busa. They obtained permission with some difficulty to descend the river in canoes, and after many adventures and dangers reached the sea, and the problem of the Niger had been solved.*

Further exploration was carried on by expeditions sent out by the Government, but in 1865 the British Government of that day had washed its hands of further exploration, and apparently took no

* A popular account of the adventures of these early explorers will be found in *Pioneers in West Africa*, by Sir Harry Johnston.

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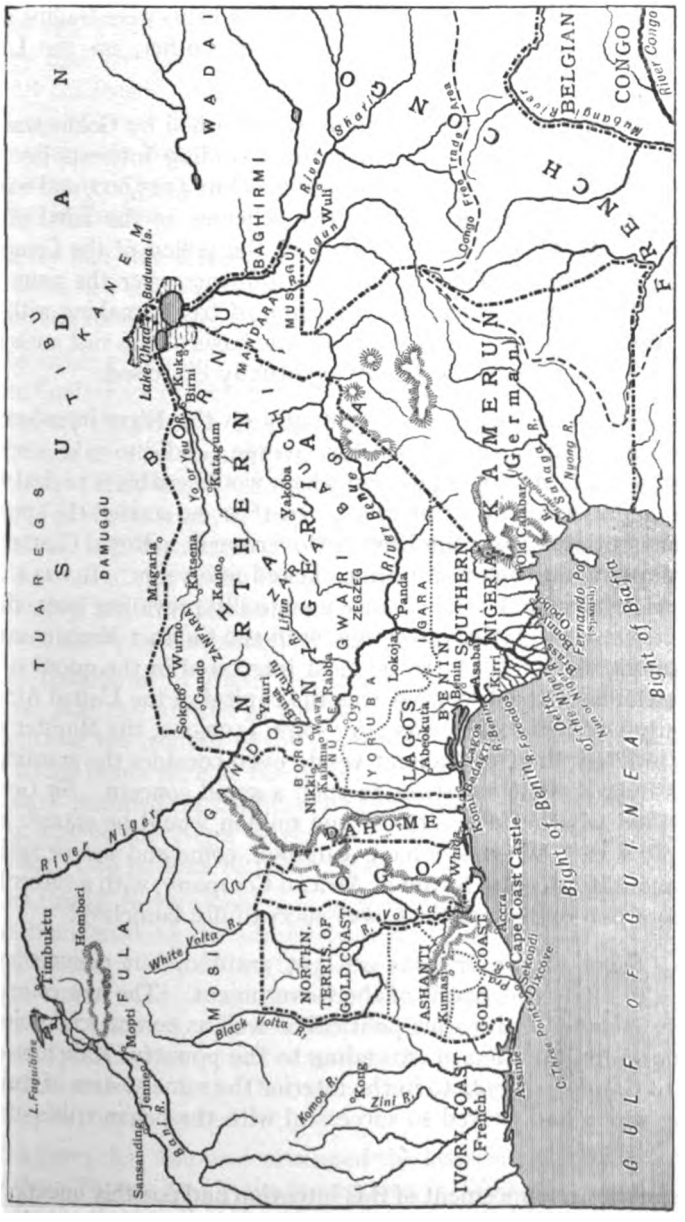

By courtesy of Messrs. Blackie & Son, Ltd., Glasgow.

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more interest in the immense possibilities of the country. The field was thus left open for private enterprise, and in 1877, the date of Goldie's first visit, a number of enterprising firms were trading independently, and in competition with each other, on the Lower Niger.

The first task in his great design accomplished by Goldie was the amalgamation in 1879 of these various trading interests into the United African Co., Ltd. The capital was but £125,000, and was no measure of the great and beneficent schemes in the mind of the organizer. It was a deliberate part of the policy of the Company to extend as far as possible political influence over the numerous tribes of the Lower Niger, and a system of treaty-making with the chiefs was entered into, which formed the basis of the vast authority which the Royal Niger Company eventually exercised.

The appearance of a French company on the Niger introduced a disturbing element, and caused Sir George Goldie to take steps to obtain for the Company a position which would enable it to deal with foreign aggression and interference. In 1881, he started the application for obtaining from the British Government a Royal Charter for the Company, and the negotiations lasted five years. It was a case of determination and perseverance eventually prevailing over official indifference. At his first interview with the Cabinet Minister whose department seemed likely to be most interested in the question, Sir George Goldie was asked what was the capital of the United African Company. When told it was only some £100,000, the Minister said it was unlikely the Government would even consider the granting of powers over so vast a district to such a small concern. Sir George then asked whether a capital of one million would be enough, and the reply was, "When you have a million, come and see me again." Eight months later the National African Company, with a subscribed capital of one million sterling, was successfully launched!

The Charter, however, was not yet granted, but circumstances eventually forced the hands of the Government. The new company publicly included in its aims political as well as commercial objects, and stated its intention of extending to the powerful Mahommedan states of Gando and Sokoto in the interior the same system of treaty-making which had proved so successful with the pagan tribes of the Lower Niger.

The public announcement of this intention had possibly unexpected results. It awakened the interest of other European nations in the country, and brought into the field two French companies, which started to compete with the National African Company, both in trade and in political aims. French policy at that time was believed to be aiming at creating a Franco-African Empire, which would have

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extended from the present Congo Free State to the Mediterranean, and would have included the Lower Niger.

The two French companies conducted their affairs with such energy that the position of the National African Company was directly challenged, and the latter found itself forced to take up the challenge or retire from the field. After heavy outlay, the French companies were bought out, and this course was facilitated by the temporary reaction in French Colonial policy brought about by the disaster in Tonkin.

Hardly had this settlement been effected in 1884 than Germany adopted a new and vigorous Colonial policy in Africa, and declared a protectorate over the Cameroons and Togoland.

The ensuing scramble for African possessions brought about the Berlin Conference of October, 1884, when fourteen nations attended to consider the African situation. Sir George Goldie attended the Conference as the Company's representative, and, thanks to the far-seeing policy which had been adopted, he was able to declare that "The whole trade of the Niger Basin is at the present moment exclusively in British hands." The British position was unassailable, and the General Act of the Conference, which was signed on February 26th, 1885, left the territories of the Lower Niger and the lesser streams, known as the oil rivers, exclusively in British hands.

The boundaries of these territories upon the coast were, on the western side, the frontier of the British Colony of Lagos and, on the eastern side, the frontier of the German settlement of the Cameroons. The inland limits were at the time left undetermined, although they, of course included the confluence of the Niger and the Benue. Free navigation of the Niger River was also secured to the merchant shipping of all nations in peace time.

The British Government was now faced with the necessity either of itself undertaking the administration of the country or of granting the Company a Royal Charter, which would make its treaties with native states valid as against another civilized power. The latter course was adopted, and in 1886 the Charter was granted and the National African Company became the Royal Niger Company. Lord Aberdare was the first Chairman and Governor, and Sir George Goldie, Deputy-Governor.

The years that followed witnessed the keenest rivalry amongst the European Powers to obtain possessions in West Africa, and it was well for the Empire that the affairs of the Royal Niger Company were in such strong and capable hands. It will be remembered that the inland boundaries of the Royal Niger Company territories had not been fixed, and that left the question of the great Mahommedan States, of Sokoto, etc., known as the Hausa States, in the air. In

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this matter the Royal Niger Company had to face the ambitions of two first-class Powers, France and Germany. The Company had, however, acted with foresight and promptitude, and had dispatched an envoy to Sokoto, who, in 1885, obtained from the Sultan a treaty recognizing the status of the Company, and giving it jurisdiction over his territories on the banks of the Benue and Middle Niger, and certain rights of political influence and commercial privileges over the remainder of his Empire.*

When the Company had gained its Charter all treaties already made were confirmed, and the system of treaty-making was extended, the later treaties containing clauses which recognized the Royal Niger Company as the representative of the "Queen of Great Britain."

In dealing with the international situation, the Company was at all times careful to embarrass the Home Government as little as possible, and, in the case of Germany, conceded to the Cameroons their rights in an outlying province of the Sokoto Empire where the Company was represented and Germany was not. The boundary line between the Company and the Cameroons was not finally agreed upon until 1893, when it was carried as far as Lake Chad.

Similarly on the north there was great activity on the part of the French in their endeavour to reach Lake Chad from Senegambia, and to confine the Company's territories within the narrowest possible limits. But the Royal Niger Company was beforehand, and was able to show cause why the British sphere of influence should be extended to that lake; so that by the Anglo-French agreement of 1890 the northern limit of the territories of the Niger Company was fixed at a line to be drawn from Barrua, on the northern shore of Lake Chad, to Say, a town on the Upper Niger. It was understood that everything to the north of that line was to be French, and everything to the south of it was to be British, but the western boundary line of the Niger Company's territories from Say to the Atlantic coast was still left open. The same course of events then followed on the western boundary as had occurred on the north, and owing to the aggression of French expeditions resort to force was with difficulty avoided. Several French expeditions were disowned by their Government, but by 1896 matters had been amicably settled without a rupture between the two Governments. Thus for the first time the Company found itself free from international complications.

Turning now to internal affairs, the duties of the Company were twofold. It was a trading concern earning dividends for the shareholders, and it was also charged with the administration of a vast territory. Amongst its duties of administration were the putting

* *The Making of Northern Nigeria*, by Capt. C. W. J. Orr, R.A.

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down of slave-raiding, and the eventual abolition altogether of slavery, the prevention of the importation of firearms, and also of spirituous liquors. Courts of justice were instituted, and a force of constabulary raised and equipped. This force consisted at first of 400 Hausas under British officers, the numbers later reaching 1,000. A force of civil police also was raised, and jails established.

To meet the cost of administration, the Company was permitted to raise some £90,000 of revenue by taxation. The taxes were levied wholly upon European trade, and as the Company was also the principal trader, it paid also the larger share of the cost of administration.

In 1896, there came a test of the authority of the Company which would have caused its downfall, if it had not been promptly and successfully met. The trouble arose with the Mahommedan Emir of Nupe, who owed allegiance to the Sultan of Sokoto. This Emir refused to desist from slave-raiding expeditions, in spite of protestations and finally threats from the Company, and it became clear that if the obligations as regards stopping slave-raiding were to be carried out, it must in this case be by force. An expedition was accordingly organized by Sir George Goldie, and accompanied by him in person. The army of the Emir was estimated at nearly 30,000 men, of whom about 10,000 were mounted. The utmost force that the Company could bring together was 550 out of the 1,000 Hausa troops in its service. Every possible precaution was taken, and every detail was carefully thought out to avoid the failure which would have proved fatal to the Company. Advantage was taken of half the Nupe army being across the river on a slave-raiding expedition, and in January, 1897, the force of 550 constabulary left Lokoja for the Emir's capital at Bida. The Emir himself at the head of from 10,000 to 15,000 men, mostly mounted, attacked the column outside the walls of his capital. He was quickly defeated, and the town was occupied next morning. The Emir, who had fled, was deposed, and the heir-apparent installed in his place. The southern portion of Nupe which had suffered most from the Emir's slave-raiding was brought under the Company's protection, and the legal status of slavery was abolished throughout the whole of Nupe. Sir George Goldie then visited the Mahommedan Emir of Illorin, who, after a show of resistance, accepted the same terms as had been settled with Nupe. By these brilliant operations it was made clear to all within the Company's sphere of influence that slave-raiding and oppression would not be tolerated.

This expedition brought Sir George Goldie a telegram of hearty congratulations from Lord Salisbury: "The arrangements which brought about the defeat of the Foulahs and capture of Bida appear to have been admirably devised and brilliantly executed." The

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native population of the new districts were also overjoyed at their deliverance from the ancient oppression.

Events were now moving quickly to the time when the administrative duties of the Royal Niger Company would be taken over by the British Government. The effect of the expedition to Nupe, coupled with the difficult relations with France on the north-west frontier, was that the Government itself raised an Imperial local military force on the Niger. It consisted of two battalions of infantry, two batteries of artillery, and a company of engineers, and was known as the West African Frontier Force. It was raised and commanded by Colonel Lugard, who left England with a Staff of officers in March, 1898.

In June, 1899, Lord Salisbury addressed a letter from the Foreign Office to the Treasury, in which he stated that he had for some time past had under consideration the question of approaching the Royal Niger Company, with a view to relieving them of their rights and functions of administration on reasonable terms. He had arrived at the opinion, he said, now that the ratifications of the Anglo-French Convention of June 14th, 1898, had been exchanged, and that the frontiers of the two countries had been clearly established, that it was desirable on grounds of national policy that these rights and functions should be taken over by Her Majesty's Government. "The state of affairs created by this Convention," he wrote, "makes it incumbent on Her Majesty's Government to maintain an immediate control over the frontier and fiscal policy of British Nigeria, such as cannot be exercised so long as that policy is dictated and executed by a Company which combines commercial profit with administrative responsibilities." Lord Salisbury therefore requested the Lords of the Treasury to endeavour to come to an early settlement with the Company.*

An agreement was come to between the Treasury and Sir George Goldie on behalf of the Niger Company, and this was set out in a Treasury Minute dated June 30th, 1899, and laid before both Houses of Parliament.

On July 3rd, 1899, the Chancellor of the Exchequer (Sir M. Hicks-Beach) moved in the House of Commons "That it is expedient to authorize the issue out of the Consolidated Fund of sums not exceeding £865,000 . . . for making payments to the Royal Niger Company in consideration of the transfer to the Crown of the administrative powers of the said Company, together with their treaty and other rights, property, and for meeting the expenditure rendered necessary by such transfer." In his review of the history of Nigeria and the

* *The Making of Northern Nigeria.*

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work of the Royal Niger Company, Sir M. Hicks-Beach said, "In the work of the administration of the Company, two men, I think, stand out pre-eminent—the late Lord Aberdare and Sir George Goldie. Two Secretaries of State—Lord Salisbury and Lord Kimberley—have borne testimony in the highest terms to the energy, the ability, and the resource displayed by the promoters of the Company, and especially by these I have named, in the work of the administration of these vast territories. Under their guidance, the Company extended its protectorate over an area of something like half a million square miles, with an estimated population of thirty million. It put down slave-raiding and massacres over a great area, it conquered the powerful Emir of Nupe, and the Sultan of Illorin, and took the town of Bida after an expedition with which Sir George Goldie's name will always be honourably connected. Some two or three years ago, it abolished the legal status of slavery within its own jurisdiction; it also did what I think is greatly to its honour, it checked materially that terrible curse of Africa, the trade in spirits with the natives. The Company further established very valuable relations with the great Empires of Sokoto and Gando, Empires which are, as compared with African tribes generally, really civilized countries. Generally speaking, it may finally be said that the Company has founded an empire extending over many thousands of square miles in the most valuable part of Equatorial Africa, and this has been done in sharp contrast with the neglect which successive Governments and Parliaments in this country have shown to British interests in that part of the world."

January 1st, 1900, was fixed as the date from which Government was to assume direct administrative control over the countries which the Royal Niger Company had thus acquired, and from that date the Royal Niger Company reverted to its *rôle* of a trading company pure and simple. Thus was completed the task which Sir George Goldie had set himself twenty-three years before.

At the final meeting of the Royal Niger Company, held on October 27th, 1899, under the presidency of the Right Honourable Sir George Goldie, the Earl of Scarbrough (the Deputy-Governor) made a speech in which he described a visit he had paid to the Niger, and the wonderful organization he found working there. "I had no connection whatever with the Company at that time, but I very quickly found out that the machinery was driven from home, and was controlled by one man; and now that the control is about to pass into the hands of the Imperial Government, we should not forget that what is written on that picture is absolutely and literally true. Nigeria was founded by one man. The organization and its development are the work of one man—with the assistance, it is true, of an admirable and able staff both at home and abroad; and it is now

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about to be handed over to the Imperial Government with its half-a-million square miles, with a waterway which is as secure for trade and traffic as the River Thames, after prolonged and most intricate negotiations conducted throughout also by one man—Sir George Goldie. In the making of Nigeria, Sir George Goldie was the master workman, whose vision perceived its possibilities, whose mind conceived the design, and whose hand laid the foundation and raised the main fabric."

Sir George Goldie administered the affairs of Nigeria from an unpretentious office in London, shunning all notoriety, which his soul abhorred. The following extract from a letter, which brings out this point in his character, has not been published before :*

" Twenty years ago, at the Berlin Conference, where I was able to do useful work which has never been made public, some leading journalists asked me to allow my name to be used, on the ground that the public cared more for personalities than for generalities; and they pointed out how I should be helping the cause I had at heart. Between then and 1900, four of our principal publishing firms have written to me or interviewed me repeatedly, urging that the time had come for issuing a biography.

" Although deeply grateful for these delicate compliments, I have throughout refused compliance. I daresay it has been partly due to excessive sensitiveness; and if this were all I should try to conquer it. But, behind that, lies a principle which has remained unaltered ever since I began to *think*, nearly half a century ago. That principle is—

L'œuvre, c'est tout; l'homme, c'est rien.

We (not I) bring our children up to think that fame, position, recognition by the public, are proper objects of ambition. I *loathe* them all. I do not believe that the world will make any great advance until children (generally) are brought up with the idea that real happiness is only to be found in doing good work, in however small (or great) a sphere.

" I felt this as strongly at 18 as I do to-day. If you say ' this is only intense pride,' I shall agree with you. I do not imagine I have a higher sense of duty or philanthropy than my neighbours. I do not assert that my pride is an amiable quality, and I conceal it carefully, except on an urgent occasion such as this, when I am compelled to open my heart freely to a friend.

" Having all my life regarded self-advertisers, from Cæsar to Napoleon, as the worst enemies of human progress, I cannot in my old

* This letter and much other information has been kindly supplied by The Earl of Scarbrough.

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age forswear my principles and join the army of notoriety-hunters—poor things.

"When my active work is over, I want (before I die) to write on this subject.

"*Una voce poco fa;* but the sea is made up of drops, and I may be able to do something to help the world to see in which direction true happiness lies."

After severing his connection with the Royal Niger Company, which he did on the revocation of the Royal Charter in 1900, Sir George Goldie travelled in the Far East, and made a particular study of the position in the Upper Yangtsi Valley. Later, he visited Rhodesia on behalf of the Chartered Company, to report on the agitation for self-government in that Dependency.

He was one of the Royal Commissioners who enquired into the preparations for the War in South Africa, and into the operations, and subsequently was similarly employed on a Royal Commission to investigate the disposal of War stores.

He was President of the Royal Geographical Society, from 1905 to 1908, and from that date was chosen an Alderman of the London County Council. He founded the National Defence Association, and was its President prior to the outbreak of the Great War: after that date his health began to fail.

As President of the Royal Geographical Society, an officer writes of him as follows:—"Goldie was an admirable President of the Royal Geographical Society. In addition to presiding over the meetings of the Society with dignity, sympathy and efficiency, he paid particular attention to the financial side of its administration. He was at all times ready to encourage young men to take their part in the work of exploration. He was always accessible and always cheerful, and had the knack of getting the best out of people. His picture, by Herkomer, hangs on the walls of the house of the Society."

Since the taking-over of Nigeria by the Imperial Government the Corps has taken its part in the development of the Protectorate, a short account of which appeared in *The R.E. Journal* for June, 1927, in the article "Some Royal Engineers and their work in Africa."

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ORGANIZATION AND TRAINING OF A MECHANICAL TRANSPORT SECTION IN A FIELD COMPANY R.E.

By LIEUT. E. W. H. CLARKE, R.E.

INTRODUCTION.

IN April, 1926, it was decided that the 17th Field Company was to be mechanized and form part of the mechanized force for trials on Salisbury Plain. During the next few months it was settled that the light six-wheel lorry was to be used for this purpose, and that the training of the drivers was to be carried out within the unit. The reasons for the choice of this vehicle and the numbers required at peace and war strength are not discussed in this article; the remarks in this article are confined to the actual training and organization of the transport section.

It was also decided that in this Company the drivers would be Sappers, and would not be organized as a separate branch in the same way as the horse-transport drivers. Whether this will be possible when a more extensive system of mechanization is adopted is debatable, but the system has many advantages. The lorry drivers were Sappers (*i.e.* drivers), and pioneers were selected for training in this work. They belong to the sections and normally parade with them, but on certain days, such as Saturday morning, they parade together for Maintenance and Inspection as an M.T. section, and a Lance-Sergeant who is a fitter-driver takes them in charge. Two of the drivers are Lance-Corporals to assist the Lance-Sergeant i/c M.T. Section. On most days only a few lorries are required for transport, and the remaining drivers work with their sections; on manœuvres, when the company halted to carry out some work such as bridge building, the lorry drivers invariably worked with the other Sappers in the sections, and the additional numbers gained in this way are very useful.

In November, 1926, two Morris six-wheel lorries were sent to the Company for training, but these were taken away a few months later, owing to the crisis in China, and training had to be postponed till May, 1927, when six Morris six-wheelers arrived.

TRAINING.

A course of instruction for training drivers was evolved, through which seven pioneer drivers (I.C.) were taken; at the end of five

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weeks' instruction, working in the mornings only, they passed out well on all tests, and could answer simple questions on the theory and working of the lorry. The men seemed to pick up the required knowledge easily, and showed a keen interest in the work. All the instruction was done by two Lance-Corporals, one specializing in the driving instruction and the other in the mechanical instruction, with the exception of a few lectures given by the officer in charge of the M.T. Section

AN OUTLINE OF THE COURSE.

First week.

Daily lectures by the officer :—

(1) High- and low-speed engines—The Otto cycle.
(2) Carburettor (cycle and lorry).
(3) Oiling and cooling systems—Regulations for lubrication.
(4) Magneto.

Practical work—dismantling motor-cycle engine, examining and naming component parts :—

Working and metallic compositions of the parts.
Examination of a carburettor, likely faults shown.
Examination in oiling and cooling systems on the lorry.
Inspection of the transmission, having removed the body.
A talk on the different types of clutches.
Examination of magneto—make-and-break, adjusting and cleaning parts.
Dismantling cycle gear-box—demonstration of working.

At the end of the week, examination questions were set on the week's work.

Second week.

Lectures :—

(1) Maintenance required.
(2) Fire and frost regulations.
(3) Care and repair of tyres.

Practical :—

Decarbonization of a lorry, grinding valves, etc.
Timing an engine—valves and magneto.
General maintenance, go through lubrication chart.
Fitting and tightening bearings.
Fault-finding on a motor-cycle engine.

Third week.

The class was split into two squads of four men each, one squad being on driving instruction, while the other worked on the lorries. Lectures were delivered to the whole class before the day's work started.

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Lectures :—

(1) Driving and road sense.
(2) Traffic and mechanized force signals.
(3) Use of gears and clutch while driving.
(4) Economy in petrol consumption (regulations).
(5) Reporting accidents.

Practical :—

One squad always on driving.
The other examining electrical equipment and looking to care of same.
Removing engine from chassis and fitting new clutch.
Re-assembly and re-timing of a lorry engine.
Adjustment and re-lining brakes.

Fourth week.

Lectures :—

(1) Mechanized Force Standing Orders.
(2) Precaution and rules in case of aerial attack.

The squads change over and repeat previous week's work.

Other work :—

Practise fitting tracks.
Test accident case to be reported.

Fifth week.

Revision questions.
Passing out drivers.
Scheme—Work in column as with Mechanized Force.

In addition to this course of instruction, lorry drivers should be taken through a course of map reading, to ensure that they are up to the standard of a Second Class Certificate of Education.

ORGANIZATION OF M.T. SECTION.

Additional lorries are being provided next year for bridging stores, but the present organization is for three lorries per half-company for personnel and one lorry per half-company as a tool cart, and one reconnaissance car for headquarters. There are four motor-cycles, which are used for D.O.s and by officers for reconnaissance purposes.

The lorries for personnel normally accommodate twelve men, the driver and the N.C.O. i/c. lorry in front, with ten men behind, and any stores are carried in the well of the body.

The lorries for tools do not differ from the others ; the tools are packed in boxes which lift in and out of the vehicle. The contents of these boxes, plus 26 picks and 27 shovels fitted in the well, are equivalent to those of a double tool-cart. Thus you have a complete set of tools with each half-company, and should a section be sent off on detachment, tools are drawn from the half-company tool-lorry and carried in the section lorries.

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Procedure on the breakdown of a personnel-lorry is to distribute the personnel amongst the other lorries and leave the M.T. Section-Sergeant and the driver to remedy the defect and rejoin the column as quickly as possible. Similarly, on the breakdown of a tool-lorry, the boxes are transferred to a personnel-lorry, and the personnel distributed amongst the other lorries, and again the M.T. Section N.C.O. and driver are left to put the trouble right.

Schemes for M.T. Section.

From time to time schemes are held under the supervision of the officer i/c. Section, which were developed on the following lines :—

Phase 1. Lecture on points to observe, such as cover from aircraft, keeping closed up, procedure on road-blockage. Go through route it is intended to follow. See each lorry is supplied with a map.

Phase 2. 30 minutes—this is the normal warning to units to move off, in which time oil, petrol and water-levels are checked, engines are started and vehicles drawn up at the assembly point at 15 yards' interval, ready to move off.

Phase 3. Vehicles move off with the driver and spare driver on each lorry, the Section map-reader rides on the front lorry and is responsible for the route.

Points practised on the route.—Halts.—Mechanical defects, putting them right and rejoining the column.—Road blockages, reconnaissance of route round the obstacle.—Cover from aircraft.—Passage of boggy ground.—Fitting tracks before doing so.—Casualties among the drivers, spare drivers taking their place without crashing.

These schemes can also be done at night, and practise guiding the column to a rendezvous by compass.

A prismatic compass reads correctly if taken 15 yards away from the lorry, and you can steer on prominent objects if visible. If not, the tail-light of a motor-cycle, sent out ahead every 400 to 600 yards and signalled into position, is used for direction For night work, the normal routine is for the leading vehicle to have shaded side-lights and a tail-light. The remaining vehicles show no light, except the tail-light. Each driver steers on the tail-light of the vehicle in front ; these tail-lights are painted over with red paint to dim them.

Motor-cycles only show a dim light, and lamps are cowled with tin, cut out from biscuit boxes and fitted between the lamp glass and the vulcanite holder. The outside of the cowl is painted black. It is essential that no light should shine upwards.

Orders.

The following pamphlets are adhered to :—

1. Standing Orders for Drivers, I.C., and Dispatch Riders.

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2. Notes for guidance of Section Officers and N.C.O.s in M.T. Companies, R.A.S.C. Also certain routine orders are worked to:—

(1) All vehicles are washed down and drivers run over nuts and bolts on completion of the day's work.
(2) All levels are checked before starting the day's work.
(3) All vehicles are greased and go over the inspection pit for general maintenance weekly.
(4) Sumps, gear-box and axle are emptied and replenished with fresh oil quarterly.
(5) Body and chassis are painted yearly, and the engine with heat-resisting paint twice yearly.

INSPECTIONS.

Are carried out:—

(1) Weekly by the Section N.C.O.
(2) Fortnightly by the Officer i/c. Section.
(3) Monthly by the Maintenance and Repair Unit.

The results of these inspections are recorded and faults rectified. Vehicle inspection reports (G. 3128) are filed in the A.B. 5s of the vehicle concerned.

BOOKS AND FORMS.

Every driver keeps a log book for his vehicle; it is divided up into the following columns:—

Date.	Speedometer reading.		Destination and nature of journey.	Stores received Petrol, Oil and Grease.	Remarks.
	In.	Out.			

It is most important that these should be kept accurately and up-to-date, as the entries in these books are the unit's only check against issue-vouchers for petrol and stores received from R.A.S.C. The men take more trouble to keep a neat and accurate book if they are given a decent-looking ruled book with stiff covers.

From personal interest a log is kept, which is compiled monthly when checking the log-books, showing the saving on R A.S.C. Transport by using unit mechanical transport during the past month. This is useful in accounting at the end of the year, to show how the motor-transport is comparing in cost with unit horse-transport.

From these books the vehicles' log-sheets (G. 3519) are compiled monthly by the Section N.C.O. and checked by the Section Officer against issue vouchers received from R.A.S.C. They are then filed in the A.B.5 of each vehicle and stuck in.

The lorries can be used for recreational training purposes at the discretion of the O.C., but if used for the purpose A.C.I. 364 of 1926 must be adhered to.

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Stores.

The C.Q.M.S. has charge of all stores and spare parts. They are indented for from the R.A.S.C. depôt, Feltham, and on receipt are entered in a loose-leaf ledger (A.F.G. 3927), which has a separate leaf for every item of equipment of the vehicle. The stores are kept in a locked store, and the C.Q.M.S. is sole possessor of the key; windows are covered with heavy X.P.M. inside. Numbered lockers with bin cards (A.F.G. 3928) show stock on hand. When any part requires replacement the Section Officer signs an A.F.G. 828 for the article, which is issued by the C.Q.M.S. to the driver, who signs for it and hands in the damaged article in lieu. These damaged articles are held on charge until the D.I.M.T.'s inspection, which occurs about twice a year, and on this inspection he gives authority to write off any damaged articles shown to him.

Lorries and their kits are held on ledger charge by C.Q.M.S. The driver signs a A.F.G. 1092 on receipt of lorry and kit, and is responsible for their safe custody; he keeps a copy of the G. 1092 himself. Every lorry's tool-box has a padlock, and the driver is the sole possessor of the key. The key of the garage containing the vehicles is retained by the Section N.C.O., who is responsible that it is locked nightly after the return of the last vehicle. With these regulations few stores are lost.

As can be seen, one C.Q.M.S. cannot possibly compete with the above ledger work in addition to his normal duties, so a mechanized unit requires a trained N.C.O. to assist him with the work.

Conclusion.

The Morris six-wheel lorry was found to be entirely satisfactory for this work. The early models had a weak clutch, but this has now been remedied, and no troubles of any kind were experienced. An average speed of 18 miles an hour can be maintained on most roads, and the lorry has a very good cross-country capacity. Very little maintenance work is required, and even when the lorry is used every day, an hour a week on maintenance is sufficient in addition to the periodical overhauls. As regards training, no difficulty was experienced in teaching the drivers within the unit, though this might not be possible in every case, if an extensive scheme for the mechanization of R.E. units was adopted. The drivers soon became experienced, and the total damage throughout the training in 1927 consisted of one bent mudguard.

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THE SCIENCE MUSEUM AT SOUTH KENSINGTON.

By COL. SIR HENRY G. LYONS, F.R.S. (R.E. *retired*).

ON March 20th, 1928, H.M. The King will open the new buildings on the west side of Exhibition Road, which have been constructed to house the collections illustrating Science and Industry in the Science Museum. Provision was made for the Art collections in the Victoria and Albert Museum twenty years ago, but it is only now, after many delays and interruptions, that the Technical Museum has a suitable building in which to display its collections.

The officers and men of the Corps have been closely connected with the development of the Technical collections during the whole of the seventy years that they have been at South Kensington, and the part that they have played in forming them and in determining their aim and scope is now so nearly forgotten that it should be placed on record.

After the Exhibition of 1851 considerable funds remained in the hands of the Royal Commissioners of the Exhibition, as well as certain collections, objects, etc., which had been presented, or which had been acquired by the Commissioners. In their Second Report they proposed that "an institution should be created which should serve to increase the means of Industrial Education, and to extend the influence of Science and Art upon productive industry." The Science and Art Department was formed in 1853 as a result of their recommendations, and Museums of Science and of Art were included in the scheme as essential parts of it.

The collections which had been formed by them were first brought together in Marlborough House, at the offices of the Department, until a building was available for them at South Kensington, where the Royal Commissioners had acquired a considerable extent of ground, and in the south-east corner of it they erected a large iron-roofed building, long known as the Brompton boilers In 1856, a detachment of Sappers was employed in transferring the collections from Marlborough House to South Kensington and arranging them there in the iron building. The detachment was housed in buildings which were already in existence on the site, and remained there to provide the skilled labour which was needed in the Museum, and to furnish a fire picquet for duty when required.

For many years after this, a small R.E. detachment was maintained at South Kensington for duty in the Museum. They worked as skilled artisans in the workshops, provided photographers for the studio, carried out necessary repairs, for some time constructed the Museum furniture, and generally rendered all technical services that were

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needed, besides guarding the buildings and their contents against fire. The detachment was withdrawn towards the end of the last century, though a few men stayed on to complete their service. The last member of it retired from military service and took up civil employment on the Museum staff on April 1st, 1900. Several others also had joined the civilian staff from time to time as photographers and in other positions. Not only the Museum but the Solar Physics Observatory at South Kensington gained very largely from the assistance given by R.E. photographers, who also took part in several eclipse expeditions.

In evidence given before a Select Committee of the House of Commons, which reported on the South Kensington Museum in 1860, it is stated that at that time the detachment consisted of about thirty-five or forty men; they are described as "most valuable workmen, and in reference to photography they have been thoroughly instructed and understand the business well." There are now twenty on the staff of the Science Museum who have served in the Corps, and ten more who served with R.E. units during the War.

The first Royal Engineer officer who held an appointment in the South Kensington Museum was Captain Francis Fowke, who, on the termination of his duties in connection with the Exhibition of 1851, was appointed Inspector for Science and Art in 1856, and had charge of the collection illustrating construction and building materials. He designed a series of brick buildings on the north side of the iron buildings, which were used for picture galleries and for the art collections and library. These have been incorporated in the north-east part of the present Victoria and Albert Museum. He also designed a Museum for the Department of Science and Art, which was to face Cromwell Road, and to provide accommodation for the Science and the Art collections. It would have occupied approximately the same site as that of the Victoria and Albert Museum, but it was never built.

The Museum of the Patent Office was also housed in the iron building, but this remained under the Commissioners of Patents until 1884, when this collection of historical objects mainly relating to mechanical engineering was transferred to the Science and Art Department, and was incorporated into the engineering collections.

In 1860, Lieutenant J. F. D. Donnelly was posted for duty with the detachment at South Kensington, and later took up duty with the Science and Art Department, of which he eventually became Secretary.

Among the R.E. officers who have been closely connected with the Museum at South Kensington should be mentioned Major-General E. R. Festing, F.R.S., who was appointed Director of the Science Museum, in 1895, as the officer in responsible charge of the Science and Engineering collections. He was also responsible for the provision of furniture for the whole of the South Kensington Museum and for such repairs and maintenance as had to be carried out.

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Sir William Abney, F.R.S., joined the Science and Art Department as a Captain, and was Director for Science in it when General Festing was Director of the Museum. He was, later, Principal Assistant Secretary of the Science and Art Department, when he was largely responsible for the policy followed in the development of the Science Museum.

Colonel H. C. Seddon, too, was a member of a Departmental Committee which reported on the Science Collections in 1881 and 1882, and he also advised on the development of the Building Construction collection. There were, no doubt, many others who from time to time helped the Museum in its earlier years.

The Royal Commission of the Exhibition of 1851, in their Second Report of 1852, had in mind national museums of both Science and Art, but, as years passed by, the Art collections were the more energetically developed. Towards the end of the nineteenth century, the object of the Science collections was definitely laid down as being the teaching collections of the Normal College of Science. It was not until 1907, when the Imperial College of Science and Technology was established at South Kensington by bringing together the Royal College of Science, the Royal School of Mines, and the City and Guilds Engineering College in a single organization, that the Science Museum was once more free to develop as a National Museum. A year or so later, the new buildings of the Victoria and Albert Museum were opened, and in them the Art collections were displayed in a manner worthy of a national collection. The striking disparity between the conditions under which the Art collections and those illustrating Science and Industry were now housed and exhibited led to representations being made by an influential group of the leading men in these branches of national activity, with the result that the President of the Board of Education appointed a Departmental Committee to enquire into and report upon the conditions and the future development of the Science Museum, and the buildings required for it. In their report, which was published in 1912, the national status of the Museum was once more emphasized, and they recommended that the old buildings, in which the collections were housed, should be replaced by new four-storied buildings. It is the first, the eastern, block of these new buildings which is to be opened on March 20th.

The new buildings are situated between the British (Natural History) Museum on the south and the Imperial College of Science and Technology on the north; they will, when complete, extend from Exhibition Road to Queen's Gate, and will then have a total length of 1,130 feet. The main entrances in Exhibition Road and Queen's Gate open direct into entrance halls, from which access is given by broad flights of steps into spacious top-lit lighting halls 120 feet long by 40 feet wide, roofed at the third-floor level. A similar large lighting hall is arranged at the centre of the building.

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The intermediate galleries, connecting the galleries surrounding the east, central and west lighting halls, are 72 feet wide, and are arranged so that the structural columns form a central gangway 12 feet wide with 30-feet galleries on either side.

Demonstration rooms, in which lectures can be given to parties of students, are provided.

The approximate areas in the complete scheme are :—

Exhibition galleries	397,000 ft. sup.	
Lecture theatre	6,000	,,
Demonstration rooms	16,000	,,
Halls, stairs, etc.	25,000	,,
Basement, workshops	159,000	,,
	603,000	,,

In the eastern section, which alone has been completed up to the present time, the area of exhibition galleries is about 143,000 ft. sup., of basement, workshop, 59,000, and of demonstration rooms, halls, stairs, etc., 27,000. About a quarter of the collection is still housed in the old buildings, originally constructed for the Exhibition of 1862.

The columns, and column foundations, floors, roofs and all constructional units of the building are in reinforced concrete, on the Coignet system. The staircases are formed in reinforced concrete, and finished with 2-in. York stone treads and granolithic risers.

The loadings allowed in calculating the structures are :—Foundations, 3 tons per sq. ft. (on gravel) ; Ground floor, $2\frac{1}{2}$ cwt. per sq. foot ; 1st and 2nd floor, 2 cwt. per sq. ft. ; 3rd floor, $1\frac{3}{4}$ cwt. per sq. ft. ; roof, 65 lb. per sq. ft. ; offices, etc., 100 lb. per sq. ft.

The main east front to Exhibition Road is shown in the photograph. Internally, the walls and ceilings are finished with a simple plaster treatment. The floors are of oak boarding on fir battens. Along all the galleries is an elaborate system of ducts for accommodating the lighting, gas, compressed air and heating mains. The compressed air is used for operating the working models of various types of engines and machines, of which there are about 300 in the Museum. The lighting of the galleries, all of which are side-lit, is particularly satisfactory, the proportion of glass to floor area being 1 to 5, or if the glass roofs of the halls and of a top-lit gallery on the ground floor are included 1 to 4.

The addition of this new block has more than doubled the exhibition space in the Museum, which is now 193,000 ft. super, as compared with 88,000 ft. super in 1913, and it has been possible to develop the collections considerably, and to adopt a definite policy in regard to them. In each group a series of objects is being formed, which is carefully selected so as to illustrate important stages in the development of the group. This historical series is supplemented by a

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second series which represents current practice, and which therefore changes frequently. In this way the Museum is both a Museum in the sense that it preserves records of past achievement, and a permanent exhibition of Science in its application to industry as shown by modern examples.

From time to time also, exhibitions are arranged at which Research Associations and Institutions can exhibit the results of their recent discoveries and investigations.

The eastern galleries, which have only just been completed, contain the collection of ship and boat models illustrating the construction of all types of water transport from early times, and from the practice of primitive races down to the present date. It is one of the most comprehensive collections of its kind in existence, and occupies three large galleries, and a reserve collection is available for reference in a basement store.

The ground floor is occupied by stationary engines and locomotives, among which are three engines designed by James Watt and built by Boulton and Watt late in the eighteenth century, also the Puffing Billy, the Rocket, the Agenoria, and the Sans Pareil, some of the earliest locomotives in existence.

In the west gallery is part of the Aeronautical collection, which is probably the most complete that there is. The gliders of Lilienthal and Chanute, the aeroplanes of Cody and Latham, and now, for a while, that flown by the brothers Wright in 1903. A series of about 80 aeroplane models illustrates the development of heavier-than-air aircraft from 1903 to 1928. The Vickers-Vimy aeroplane which Sir John Alcock flew across the Atlantic in 1919 is also here.

On the first floor are the collections of Mining and Metallurgy, a very interesting series of Tools and Machine Tools, and another of Textile Machinery. Part of the collection illustrating Electrical Engineering is on this floor, where automatic telephone exchanges may be seen in operation and are demonstrated daily.

On the second floor Pumping Machinery and Engineering Construction are shown, as well as collections of Mathematical Instruments, Time Measurement, Geographical Instruments, Electrical Instruments and Meteorology.

The rest of the Science Collections, Chemistry, Optical Instruments, Geodesy and Surveying, and Astronomy, are on the third floor.

Since improved accommodation has been available, and it has been possible to display the objects more effectively, the attendance of visitors has increased to a very remarkable extent; in 1927 the number of them was 710,000, and it is increasing steadily. After a long period of slow development the Museum has now reached a truly national status, and its organization and methods have commended themselves to many who are developing similar institutions in other countries.

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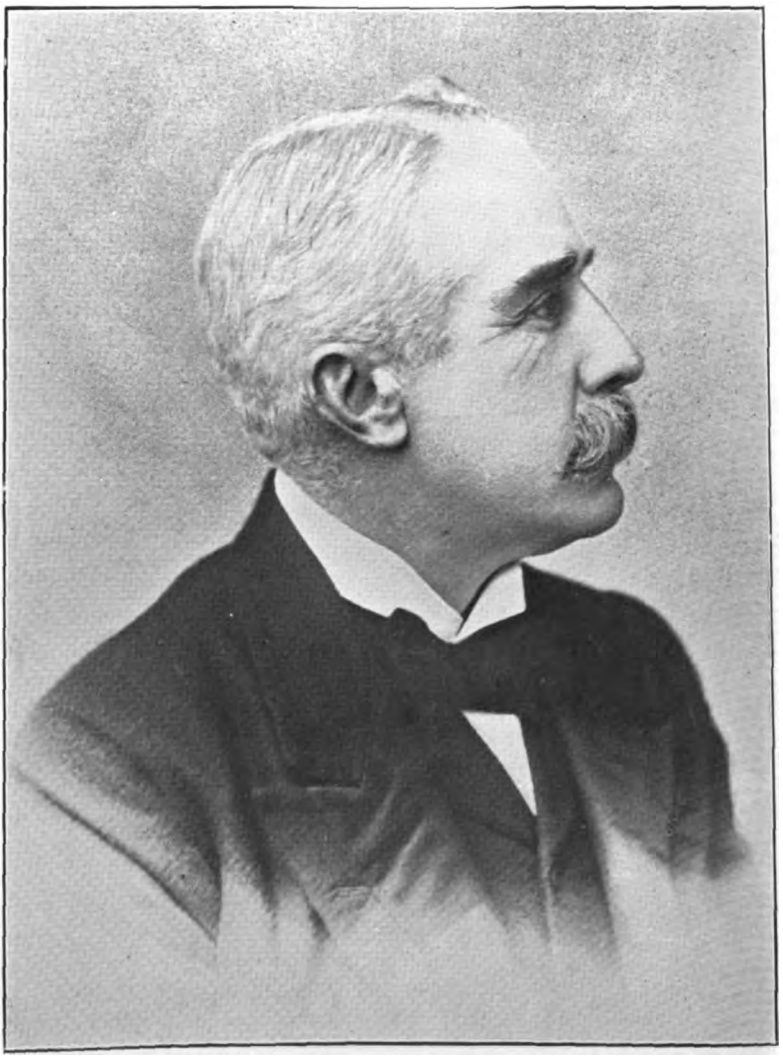

Colonel John Edward Blackburn, C.B.

Photograph by Searle Bros., 191, *Brompton Road, S.W.*

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MEMOIR.

COLONEL J. E. BLACKBURN, C.B.

GENERAL SIR BINDON BLOOD, referring to the subject of the following memoir as " my old friend and comrade in Egypt, 1882–83, and my best man afterwards when I was married," uses words regarding him which those who knew Blackburn best will appreciate most.

" He was one of the best, a right good soldier, a first-rate Sapper, and a good sportsman, and it was good for a man to be his friend."

John Edward Blackburn, the eldest son in a family of six brothers and six sisters, was born at Edinburgh on April 30th, 1851: his father, Robert B. Blackburn, was at that time practising at the Bar in Edinburgh, and subsequently became Sheriff of Stirlingshire. His uncle was the very distinguished lawyer and Lord of Appeal, Lord Blackburn, whilst the legal tradition in his own generation is carried on by his only surviving brother, who is a member of the Scottish Bench with the title of Lord Blackburn. A younger brother, Leslie, in the Scottish Rifles, had a military career of great promise, but was killed at Tuli in the early stages of the South African War. Our Blackburn as a boy was at school for two years at Glenalmond, followed by three years at Eton from 1864 to 1867, when he left to be successfully coached for Woolwich at Mr. Brackenbury's famous Establishment at Wimbledon. His first commission was dated December 12th, 1871, when he was twelfth in a batch of twenty Cadets, of whom the late Sir Henry McCallum was head, then gazetted to the Corps. A contemporary writes, " Blackburn, or ' Bunny,' as " we used to call him, was a great friend of mine both at the ' Shop ' " and afterwards at Chatham. We neither of us played football at " Woolwich, having both been brought up to the dribbling game. " Soon after we joined at Chatham he induced me to play there, and " all the time we were at Chatham, viz., 1872–73 and 1873–74, we " played together in the R.E. team—Blackburn played on the right " wing with Von Donop (in the same batch), and they were a splendid " pair, and never failed to give us centre-forwards chances of scoring " by centring at the proper time."

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This period was the hey-day of Association football at Chatham: we were in the final of the Association Cup in 1873–74, and won it in 1874–75, but Blackburn's name does not appear on the latter occasion, probably because he had left Chatham for Aldershot before the match came off. He was, however, a member of the team that made the historic football tour in the North of England early in 1874, beating Sheffield, Nottingham and Derby on their own grounds, and receiving a most enthusiastic welcome from the crowds of spectators.

Blackburn went to Aldershot when his time at the S.M.E. came to an end, and joined the R.E. Train, and served with it for over three years.

The R.E. Train consisted of A or Pontoon Troop, B or Equipment Troop, C or Telegraph Troop, and the Field Depôt, which received and trained all recruits for the Train, mounted and dismounted. The Train was commanded by a Lieut.-Colonel, with an Adjutant, and was kept quite distinct from the R.E. Companies, whilst its officers and men were not employed in the Works. The Train was in a sense the branch *d'élite* of the Corps, the officers joining it getting their "jacket," as did a Gunner on being posted to the R.H.A.: an examination of the names and records of those who served in the Train discloses how great its value was as a means of producing efficient officers.

When Blackburn joined it, the Train included many well known to fame; Sir Howard Elphinstone commanded it, with Lieut. Jelf as Adjutant: Major Micklem commanded A Troop, to be succeeded by Lieut.-Colonel Harrison, now Sir Richard Harrison: whilst the junior subaltern in Major Durnford's C Troop was Lieut. H. H. Kitchener.

The Train as a separate organization came to an end in 1877, (just as Blackburn left it), when B Troop was broken up between the Field Companies then for the first time formed, and the command of all R.E. personnel at Aldershot passed into the hands of one officer, with the title of O.C. Troops and Companies.

At Aldershot, Blackburn, his nickname altered from "Bunny" to "Brush," spent three happy and useful years: he donned the scarlet stable jacket peculiar to the Train, wore spurs on every possible occasion, and, for all we know, may have grown the side whiskers of the period. Popular with all ranks, we may be certain he did not waste his time, and the fact that Blackburn was a first-rate regimental officer was due to the lessons learnt in his early years at Aldershot. Foreign service at Jamaica now claimed him for three years, at the end of which he joined the 26th Field Co., R.E., then commanded by Major, now General, Sir Bindon Blood. In 1882, Blackburn

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competed in vain for the Staff College, but the autumn of that year gave him his first experience of active service, in the Egyptian Campaign of 1882, with the battle of Tel-el-Kebir. In the following spring he was ordered home in anticipation of promotion, and commanded the 21st Company at Aldershot until the autumn of 1884, when he returned to Egypt as part of the reinforcements for the approaching effort to save General Gordon.

He rejoined his old Company, the 26th, which in his absence had been fighting under Sir Gerald Graham at El Teb and Tamai, just in time to form part of the detachment which was the first body of troops to ascend the untried cataracts of the Nile in English-built whalers. Blackburn wrote a very interesting account of the Boat Expedition for *The R.E. Journal*, and portions of it will be found incorporated in the second volume of the *History of the Corps*.

When the Expeditionary Force divided at Korti, part going across the Bayuda Desert and part following the Nile, it fell to Blackburn's lot to command the R.E. detachment with the River Column, and he was present with it at the battle of Kirbekan.

It was during these eventful times that the writer first met Blackburn, and the impression remains of one amazingly cheerful under difficulties, who never thought of himself, was everybody's friend, and who always played the game.

Blackburn was mentioned in dispatches at the end of the campaign, but without reward; he stayed on in Egypt with the Frontier Force, saw further fighting with it, and was again mentioned in dispatches. Again the fates were against him in the matter of rewards, and when he finally left Egypt in February, 1886, for peace service at Gibraltar, where he commanded the 18th Co., R.E., he did so without any solid recognition of his services in the three different "shows" in which he had been engaged.

In September, 1887, he took the 18th Co. to Halifax, where he remained until his foreign tour expired in February, 1889. A "Gunner" friend, writing of Blackburn in Halifax, says:

"I have a clear recollection of Blackburn as an ever-sunny presence—as one of those whom one is lucky to find as a brother officer in one's Mess. The R.A. and R.E. Mess at Halifax was a very happy family, but there was always lots of chaff going. Nothing ever ruffled Blackburn: the shrewdest dig at him was met with a cheery smile. He joined in all the many sports that Halifax, in those halcyon days, was famous for providing."

After a year in the London district, when he occupied the little quarter at Kensington Museum which was the home of a succession of R.E. officers, he was given the command of the 7th Field Co.,

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which he held for four years, mostly spent at Aldershot. There were changes there, of course, from former days: the attractive old Mess hut with its cluster of officers' quarters, its neat compound and beautifully cared-for flower beds, had gone for ever, and the present Mess had just been built.

The stable jackets were nearing their end, and the side whiskers had long gone, but the "Troop" spirit and tradition were still alive in the Bridging Battalion, with its A and B Troops, and in the 1st Division Telegraph Battalion, which was but C Troop under another name. Most of the senior officers had had "Troop" upbringing, although the C.R.E himself, a keen soldier and a wonderful drill, was new to the place, and did not always see eye to eye with the old Aldershot hands. To mention, among the men of those days, Mackworth, Jelf, Beresford, Rochfort Boyd, Dickinson, Bond and Irvine, is to recall names associated again and again with the "Troops" and Aldershot. The Troops, however, were no longer having it all their own way, for the Field Companies were on the move and coming into their own with great competition to command them.

The Maxwell "stars" were rising above the horizon, and the writer, then at Aldershot, remembers the stories that reached him of what the brothers would have to teach in the way of smartness when they invaded preserves once sacred to the "Troops." Even with such competition, it is safe to say that the 7th Field Company maintained its high traditional reputation under the command of one who knew every move of the game, and possessed all the qualities required for his post. His work as a Field Company Commander ended, Blackburn spent a year at Exeter, and then returned once more to Aldershot to command the Field Depôt for six months, and then for over a year to be Second-in-Command to the O.C. Troops and Companies.

On promotion to Lieut.-Colonel at the end of 1897, he was sent to Gibraltar, where he spent five years as one of the C.R.E.s, and where he made friends with that good friend to so many Royal Engineers—Sir George White.

During these years occurred the Omdurman Campaign and the South African War, and, although he said little, it was a bitter disappointment to Blackburn to miss both at a time when some of his Egyptian comrades were seeing all the fun.

Moreover, Blackburn from his recent experience was eminently suited to command the Engineers of a division, and it is difficult to understand why his services were never utilized during the drawn-out struggle in South Africa.

After six months on half-pay, Blackburn was given the post of Chief Engineer Northern Command, which he held for four years, and on

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30th April, 1908, he was placed on retired pay on reaching the age limit.

In the Great War, Blackburn was reappointed Chief Engineer Northern Command in January, 1915, and in difficult circumstances mastered the many Engineer problems which the great expansion of the Army involved. He held the post until relieved by a serving officer in June, 1916.

It was the good fortune of the writer to be again associated with Blackburn in these last days of his military service, and all the qualities that won our hearts on the Nile were still his in unabated strength. Blackburn was mentioned in dispatches for distinguished services rendered in connection with the War, and was made a Companion of the Bath—a well-deserved reward for what he did in the War and in those early unrequited years of active service.

Blackburn never married, but lived with his sisters, to whom he was devotedly attached, and to whom he was the best of brothers.

In his latter years he got attacked by arthritis in the hip, and suffered much, although few could have guessed how much. His cheerfulness and courage in ill-health were as marked as they had been under difficulties of another nature. He was an example to all of how the infirmities of the flesh may be conquered. His closing years were spent in London, where he had a flat with one of his sisters, and, very much crippled, he was to be found most of the day at the United Service Club.

The "Gunner" friend of Halifax days, referring to this period, writes: "Crippled as he was, he was still the same cheery soul as "of old—always ready to give and take chaff with an infectious "laugh and ready even to make fun of his own infirmities. I am "sure that those whom he meets when he has gone will be happier "for his coming."

The writer had a talk with him at midday on the 28th of September last, and "Blackie" was cheerful and apparently quite well. He died suddenly and peacefully early in the following morning, a great shock to his relatives and friends, but for him surely the happiest of endings.

H.M.L.

6th February, 1928.

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PROFESSIONAL NOTES.

ACID-PROOFING FOR TABLE TOPS.

(From *The Builder*, December 30th, 1927.)

THE following recipe has been used by the writer (an Assistant Engineer, Madras Public Works Dept.) quite successfully for acid-proofing the surface of teak table tops in the laboratories of the Medical College, Madras: the surfaces, treated three years ago, are still in good condition.

Solution 1.

Ferrous sulphate	grammes	20
Copper sulphate	,,	20
Potassium permanganate	,,	40
Water to make 500 c.c.		

Solution 2.

Aniline oil	c.c.	60
Strong hydrochloric acid	,,	90
Water to make 500 c.c.		

METHOD.

Apply two coats of Solution 1 with an interval of at least 12 hours. When thoroughly dry, apply two coats of Solution 2.

When the treated surface is thoroughly dry, apply one coat of raw linseed oil with a cloth. When this is dry, wash with very hot soap-suds. The excess of black should be washed off after 48 hours with soap and plenty of water. Occasional washing keeps the surface quite clean.

The surface to be acid-proofed should be quite fresh, or if previously coated with varnish, oil, or paint, it should be thoroughly scraped and cleaned.

VICTAULIC PIPING.

Communicated by the R.E. Board.

AN article on the Victaulic Patent Pipe appeared in *The R.E. Journal* in 1925, Vol. XXXIX, p. 475, but, although this has been the subject

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of a D.W. contract for several years, it is thought that its advantages may not have been fully recognized, and that a few further notes on the subject may be of interest.

It is proposed to deal here only with its use for temporary connections: the arguments in respect of permanent work must be considered individually in each case. To test the capabilities of easy and quick laying, certain experiments have recently been carried out under arrangements made by the R.E. Board, and the results of these are shown in Table A. From this Table it will be seen that, speaking generally, Victaulic piping can not only be laid about four times as fast as ordinary screw piping, but that the labour required is less and need only be semi-skilled instead of skilled.

A test was also made on manœuvres; it was found that the use of box spanners very considerably increased the rate of laying, and these were accordingly knocked up out of short lengths of one-inch piping. Using these box spanners, a party of four men actually laid nearly 200 yards in under half-an-hour.

The advantages of these properties for all work of a temporary nature, such as camps or work in the field, need not be dilated upon: the trials prove conclusively that this form of piping is *facile princeps* for such work.

Apart from the enormous advantages of ease and quickness of laying, there are a number of other advantages which make this piping specially suitable for all R.E. work in the field: these can best be summarized as under:—

(1) *Speed of Laying.* Where long lengths have to be laid, work can be done simultaneously at various points in the line; only one pipe has to be cut and grooved at each joint, instead of one pipe and a connector as in the case of screw piping.

(2) *Dismantling.* This can be carried out simultaneously at all parts of the pipe line, whereas with screwed pipe it can only be done from the ends.

(3) No skill is required in laying or making the joints. The use of the grooving tool requires the same care as the use of stocks and dies for screwed piping.

(4) A length of pipe can be removed anywhere without any cutting. This is an enormous advantage in repairing a break or inserting a branch, as it avoids the necessity of long screws and back nuts, etc., which are essential with screwed piping.

(5) No damage can be done to the pipe in transit or by frequent laying and dismantling, whereas with screwed pipe the threads usually suffer.

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(6) No materials, such as tow, tallow, etc., are required for the joints.

(7) Fewer kinds of tools are required :—

For Victaulic.	*For Screwed Pipe.*
Two sizes Special Grooving Tool (this is also used for cutting the pipe). Vices, Box Spanners.	Stocks and Dies (sets for each size of pipe used). Vices, Footprints, 3-wheel cutters, Chain-grips.

(8) The pipe is very flexible compared with screwed pipe. This diminishes the number of bent pipes required.

(9) There is no difficulty in joining on to other sorts of piping, as the Victaulic Company makes a comprehensive list of adapters to make joint with screws and flanges.

(10) Weight is approximately equal to that of screwed piping.

The advantages of rapid laying naturally rather disappear with small piping, though there can be no doubt that with anything over 2-inch, Victaulic piping will always have a big advantage.

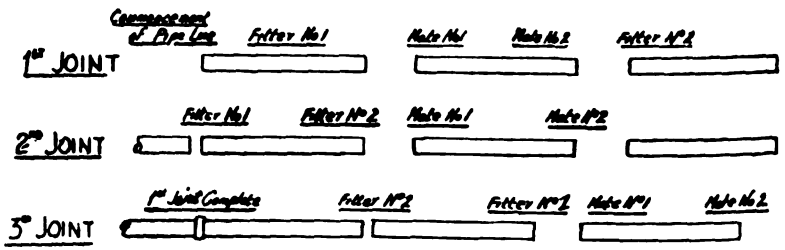
The Victaulic Company recommend a special grease for the washers and ends of pipes : this is merely a preservative and it is unnecessary for temporary work ; the tightness of the joint does not depend on its use in any way.

The following is a drill for pipe-laying which has been tried :—

Party—6 men, divided into :—

A. 2 men lowering pipes into trench.
B. 2 Fitters and 2 Mates connecting pipes.

The suggested organization of Party B. is as follows :—



Fitter No. 1.—

1. Fits rubber ring to end of second pipe.
2. Couples up first and second pipes, assisted by the two mates (who then proceed to assist Fitter No. 2).
3. Tightens up nuts of first joint with spanner.
4. Proceeds to fourth pipe and does the third joint as before.

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Fitter No. 2.—

1. Fits rubber ring to rear end of third pipe.
2. As soon as the two mates arrive he couples up second and third pipe.
3. Tightens up nuts of second joint with spanner.
4. Proceeds to fifth pipe and does the fourth joint as before.

Mate No. 1.—Always assists the fitter (1 or 2) until the nuts of the joint are hand-tight: he then joins the fitter at the next joint.

Mate No. 2.—Is responsible for aligning the next pipe to be joined, and is always at the head of the pipe line.

If box spanners are available this drill should be amended so that Mate No. 1 always works with Fitter No. 1, etc.

TABLE A.

COMPARISON BETWEEN SCREWED AND VICTAULIC PIPING.

Pipe Diameter.	W.I. SCREWED.				VICTAULIC.			
	Fitters.	Labourers.	Feet per hour.	Feet per man-hr.	Fitters.	Labourers.	Feet per hour.	Feet per man-hr.
4	2	10	125	10	2	8	600	60
3	2	8	150	15	2	4	600	100
2	2	6	225	28	2	4	600	100

REMARKS.—Fitters for Victaulic need not be as skilled as Fitters for Screwed piping; any Sapper can make the joint with very little training.

BOOKS.

THE ARMY AND SEA POWER.

By MAJOR R. B. PARGITER, R.A., and MAJOR H. G. EADY, M.C., R.E. (Ernest Benn.) Price 10s. 6d.

It is one of the hopeful signs of the times that co-operation between the fighting services is becoming acceptable in theory, if it cannot yet be said to be completely in being. This book is written with the object of making this co-operation more whole-hearted and more real. The Authors could not have chosen a more effective method of demonstrating its necessity than this of gathering together from history the instances when Navy and Army have worked together. Everyone will accept as true the statement that the Army is ineffective without the assistance

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of the Navy; not everyone will quickly agree to the converse. The reader of the book will, I think, be convinced that the sailor needs the soldier just as much as the soldier needs the sailor. This conviction is one of the things that are necessary to ensure that in future the services will ungrudgingly and unfailingly work together for the common end.

The story begins with the reasons for the growth of British sea-power, and it traces that growth through the struggles with Spain, Holland, France, and finally Germany. Instance after instance is given, vividly told and critically examined, in which Navy and Army have either succeeded by good co-operation, or have failed through the lack of it. Not only does it provide most interesting reading, but it makes the reader anxious to read more about many of the episodes which are to most people quite unknown.

The book concludes with a summary of the lessons which should be deduced from these operations of the Army and Navy in the past. It defines the *rôle* of the Army with regard to the Navy in the present, and it points to the probability that in the future the development of air power will involve the Army in further defensive commitments. It leaves the reader with much food for thought. War in the future will involve two, if not all three, services; it is all the more important that the conduct of combined operations should be studied by all concerned. To all those who would learn from the past in order to act rightly in the future this book is heartily commended.

N.W.N-C.

FIELD-MARSHAL LORD NAPIER, OF MAGDALA, G.C.B., G.C.S.I.

By LIEUTENANT-COLONEL the HON. H. D. NAPIER, C.M.G.

(Edward Arnold.) Price 21s.

Lord Napier, of Magdala, died in 1890, and in many ways it is unfortunate that no biography of this great man should have appeared until thirty-eight years after his death, chiefly perhaps because present-day conditions have compelled his son to limit the work to a single volume, whereas the account of so important a life, the active portion of which extended over more than sixty years, could hardly have been adequately dealt with in two. Colonel Napier explains in his Preface that the delay was due to the fact that it was originally intended that the biography should be written by Miss A. Yule, daughter of Colonel Sir Henry Yule, but time passed and Miss Yule died, and the duty eventually devolved upon him. The curtailment, he explains, has been made as far as possible in the details of the actual fighting, and for these we must turn to the acknowledged authorities on the various campaigns, as, for instance, Malleson for the Indian Mutiny, and Holland and Hozier for the Abyssinian Campaign. That Colonel Napier has carried out this filial obligation, within the limits which he has imposed upon himself, ably and sympathetically, all readers of this book will allow.

Most of us are familiar with the outstanding incidents in the life of Lord Napier, from the biographical notices in the Corps History or in

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Colonel Thackeray's *History of the Royal Bengal Engineers*. Born in 1810, he obtained his commission in the Bengal Engineers in 1826, and went to India in 1828. Not till seventeen years later did he see a shot fired in anger. He distinguished himself in canal work under Cautley, in the development of Darjeeling as a hill station and in laying out the cantonment of Umballa. Then came the First Sikh War, with the battles of Moodkee and Ferozeshah, of which Colonel Napier gives us a most interesting personal narrative. It is curious to read of the share Engineer officers took in the battles of those and earlier times, roaming about the field looking for a job, offering their services to some who do not accept them, riding in cavalry charges, charging with infantry regiments, spiking odd guns, and even as a captain offering advice to the Commander-in-Chief. Napier tells how such advice given by him to Lord Gough may have turned Ferozeshah from a defeat into a victory. He was also present at Sobraon. A year later came the little expedition to Kangra, on which he insisted upon taking eighteen-pounders and made a practicable road for them through country "unequalled in difficulty by anything" the brigadier (Wheeler) had ever seen. "My labour was not useless," he wrote, "for nothing but the arrival of the eighteen-pounders had the effect of bringing the garrison to reason." In the Second Sikh War, Napier was C.R.E. at the first siege of Mooltan. His scheme of attack was too bold for adoption. His schemes always were bold, but when in later days he was in control, he always showed that boldness was successful. For the second siege, Colonel Cheape was C.R.E. and it was mainly Napier's scheme that was adopted—and succeeded. The place fell, and both officers arrived in time to take part in the victory of Gujerat. The Punjab was annexed and for ten years Napier laboured at his great engineering work of developing the province. Surely no great general ever had such engineering experience as Napier: "1,349 miles of road have been cleared and constructed, 858 miles are under construction, 2,487 miles have been traced and 5,272 surveyed, all exclusive of minor cross and branch roads," and exclusive also of canals, public buildings, salt mines, frontier defences, bridges, works too numerous to mention. In this period he took part in two frontier expeditions, the Black Mountain, in 1852, and against the Jowaki Afridis, in 1853, in both commanding columns of all arms, Sir John Cheape only securing the "record" by two months. In 1856, Napier went home on leave, bearing with him a most laudatory letter from Henry Lawrence, which could only be quoted in full. He returned to India to find the Mutiny in full blast, and joined Outram as Chief Staff Officer. Space forbids lingering over the operations at Lucknow, the first Relief, the Defence, and Sir Colin Campbell's second Relief. Then the siege and capture, with Napier as C.R.E. It is one long tale of indefatigable heroism. Colonel Napier gives an extract from a letter, written in 1871, in which Lord Napier wrote: "I do not think any position higher than that of an engineer who, unexcited by the actual strife of battle, amid the unknown dangers of the dark night, or in the face of contending combatants by day, exercises a calm and steady courage under the consciousness that on his skill and judgment depends the fate of thousands or the issue of the campaign." In the

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Central Indian campaign of 1858. Napier was in command, and here his wonderful judgment in forecasting the action of the rebels, and his boldness in attacking them, no matter how heavily the numbers were against him, are hardly believable; but they are true and he was always successful. In 1860, he commanded the Second Division in the China War. At Calcutta he superintended the entire equipment and embarkation of the troops, every detail of equipment, food, clothing, ventilation and sanitation for sixty ships, and the security of the powder magazines, coming under his jurisdiction. Much opposition and red tape were brushed aside, and Napier was "enabled to deliver the Bengal portion of the troops in China in excellent condition, and fit for immediate service after a three-month voyage." The account of the success of his division at Sinho, and his advice to attack the North Taku Forts only, which was adopted by Sir Hope Grant in spite of the objections of our allies, the French, are to be found in Greathed's history of the campaign. From 1862 to 1865, Napier was on the Indian Council, first as Military Member and afterwards as President. He was a desperately strong man on the Council, his supreme knowledge of India and the Indians and of all military matters, and his great force of character, enabling him to carry his views against the opposition of the Secretary of State, the Commander-in-Chief, and even of the Governor-General. And yet they all loved and admired him. Even John Lawrence, whom he could never get on with, admired him. He was spoken of as the future Commander-in-Chief in India, as the future Lieutenant-Governor of the Punjab, but he became Commander of the Bombay Army, "strong representations" having removed the objections of H.R.H. The Duke of Cambridge, who could not at first agree to giving the appointment to an Engineer. This appointment led to his commanding the Abyssinian Expedition, almost entirely manned from the Bombay Army, a triumph of organization and fore-thought, carried through by Napier alone, under the eyes of all the civilized world. Perhaps the supreme moment of his life was when he refused to grant peace on the surrender of the European prisoners alone. "If Theodore would bring all the European captives to my camp and submit to the Queen of England, I would promise honourable treatment for himself and his family." The risk to the prisoners was great, but Napier knew his man, and they were surrendered unharmed, though Theodore preferred to die

> ". . . after the high Roman fashion
> And make death proud to take us . . ."

"The brilliant success of the Abyssinian Expedition, together with its strange and romantic setting, seized upon the imagination of the whole of Europe to such an extent that Napier, the most modest and retiring of men, almost 'awoke,' like Lord Byron, 'to find himself famous.'" He went back to India, in 1870, as Commander-in-Chief, having stipulated that the appointment should include a seat on the Viceroy's Council. His activity was unbounded, and so was his influence. "Lord Mayo said that everything conceded was done by him with a pistol at his head." Napier was the enemy of unwise economy, and fought

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hard for the well-being of the British soldier, devising great schemes for barrack improvement. But we must not linger over this part of his history. It was a momentous period in India, when Russian activity in Central Asia was threatening the North-West Frontier, and intrigues at Kabul were working up for an Afghan War. The efficiency of the Army was all-important, and Napier initiated Camps of Exercise, the first of which was held at Delhi, in 1871–72. In response to a special appeal from the Duke of Cambridge, Lord Napier remained in office until 1876, and was present at the great review, held at Delhi, in honour of the Prince of Wales, on which occasion he remained mounted throughout with a broken collar-bone, the result of a riding accident—he was a bold and reckless rider, and his son writes that, in his younger days, "there was nothing too foolhardy for him to attempt in feats of horsemanship." When he left India, the *Civil and Military Gazette* praised the "splendid efficiency" of the Army in India, for "which England has to thank Lord Napier and the regimental officers who have carried out his anxious endeavours to keep the regimental system by which the British Army made its fame and brought glory to its colours." In that same year (1876) he became Governor of Gibraltar. In February, 1878, when Lord Beaconsfield's opposition to the occupation of Constantinople brought us within an ace of war with Russia, he "was hastily summoned from Gibraltar . . . and was appointed to command any expeditionary force that might be sent against Russia, with Major-General Sir Garnet Wolseley as his Chief-of-Staff." He was then, as Wolseley was later, "our only general," and after the war scare had passed away was frequently summoned to London for consultation by the Duke of Cambridge. In 1879, he refused to supplant his friend Lord Chelmsford, in Zululand, after the disaster of Isandula. In 1883, he relinquished the command of Gibraltar, where he had carried forward large schemes of improvement in a large way, leading the Colonial Secretary to tell his successor "that such extravagances should not be continued." In December, 1886, he was appointed Constable of the Tower of London, and three years later he died in London, and was buried with great pomp in St. Paul's Cathedral. His statue, by Boehm, originally stood in Waterloo Place, where that of King Edward VII. now stands. In 1923, it was moved to the present beautiful site in Queen's Gate. In a leading article, on 15th January, 1890, *The Times* said of him: "Never was there a career which ascended along more regular and indisputable stages. At every point it was able to bear the minutest inspection. Nothing in it was due to favour. It owed nothing to accident, unless of the sort which offers conspicuous occasion for failure as well as for distinction." His son writes: "Other men have had greater opportunities. Some may have been as intelligent, many as brave, a few as straight, as strict in their morals and conscientious in the execution of every action of their lives, as unselfish and chivalrous, as good a father, as perfect a husband, but no one else I have ever met has appeared to me to combine all these qualities to such a degree." A great man, indeed one of the greatest.

F.E.G.S.

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MILITARY OPERATIONS: EGYPT AND PALESTINE.

From the outbreak of War with Germany to June, 1917. Compiled by LIEUTENANT-GENERAL SIR GEORGE MACMUNN, K.C.B., K.C.S.I., D.S.O. (late R.A.), *p.s.c.*, and CAPTAIN CYRIL FALLS, late 11th R.Innis.Fus. and General Staff. (H.M. Stationery Office, 12s. 6d. net; case of maps, 5s. 6d. net.)

War between the Allies and Turkey was not declared till November 5th, 1914. The delay was utilized by the Turks and their German instructors to complete their preparations for war. It was not known at the time that Germany and Turkey had actually signed an offensive and defensive alliance on August 2nd, 1914, two days before war was declared against Germany. In the absence of definite knowledge of this pact, the British and French Governments had a very difficult problem before them at the outbreak of hostilities on August 4th.

The Official Historian, in this case Lieutenant-General Sir George MacMunn, has an intimate knowledge of our military problems in the East and of our Indian Army, and is well qualified to speak on questions affecting the Moslem subjects of the British Empire. He explains the reasons for the delay in the opening chapter. The most important, of course, was the effect that war with Turkey would have on the Moslems in the countries ruled by Great Britain and France and those on their borders. There were other reasons more closely affecting British interests, more especially in Egypt, where the political situation, the position of the Khedive—who was hostile to England and was actually absent in Turkey when war broke out, the large number of Turkish Nationals in Egypt, and the defence of the Suez Canal gave much cause for anxiety. It was not till after the declaration of war with Turkey that the situation was eased by the deposition, on December 18th, 1914, of the Khedive and his replacement by his uncle, Prince Hussein Kamel Pasha, who was raised to the throne with the title of Sultan. On the previous day, Egypt had been proclaimed a British Protectorate. Although there was latent hostility to Great Britain and sympathy with Turkey as a Moslem Power, these drastic constitutional changes were viewed by the people with greater indifference than might have been expected. Expectations of some benefit to Egypt under the new *régime*, and ocular evidence of the great military resources of the British Empire, kept the people quiet.

War with Turkey was declared by both Great Britain and France on November 5th. On November 11th, the Sultan of Turkey, in his position as Khalif, immediately proclaimed a *Jihad* on all those making war on Turkey or her allies. The almost complete failure of that appeal all over the Moslem world was a complete justification of the wise policy, for which Lord Kitchener was largely responsible, pursued in Egypt and in India during the three months before Turkey came into the War.

A great deal has been heard, both during the War and after, about Alexandretta. As early as December, 1914, the importance of Alexandretta as a vital point on the Turkish lines of communications

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to Mesopotamia, Arabia and the frontier of Egypt caused a diversion in the direction of the Bay of Iskanderun to be seriously considered. The project was then rejected, for the time being, for the following reasons:—"An organized field army, with modern means of transport "and equipment for the landing of stores, would have been required, "and could ill have been spared, even if it could have been found. "The Navy would have been called upon to make the Bay of "Iskanderun secure against submarines and protect the sea route "thereto. The landing of a British Force for any operations greater "than a raid would certainly have resulted in risings (anti-Turk) of "Armenians and of some of the tribes in the Amanus region, so that, "once having entered upon the enterprise, Britain would have found it "impossible to withdraw, however urgent the reason, and leave her "friends to Turkish vengeance. For these reasons, and especially the "first, Lord Kitchener and the Cabinet decided that in existing circum-"stances the passive defence of the Suez Canal itself, on the banks of "the canal, was the only possible method of protecting Egypt from "attack by land." The question arose again a year later, but will be discussed in its proper sequence.

That the danger of an attack on the canal by land was a real one, was very soon demonstrated.

The Sinai Peninsula has always been a formidable obstacle to invaders of Egypt. In 1916, the War Office estimated that the maximum force which could be brought across this almost waterless desert against the canal could not exceed 5,000 men and 2,000 camels. But on February 3rd, 1915, the Turks, led by a Bavarian Officer of repute, and one whose reputation has been enhanced by his conduct of operations in 1915–16, Oberst Freiherr Kress von Kressenstein, now Chief-of-Staff of the 8th Turkish Corps, crossed the desert by the central route and attacked the centre section of the Canal defences with a force which, according to Kress himself, numbered 20,000 men with nine batteries of field artillery, a 5·9 inch howitzer battery, pontoons, and 10,000 camels carrying supplies and water. Thanks to good intelligence the attack was expected, and was defeated at all points, with a loss to the Turks of nearly 2,000 men, including 716 prisoners. The British loss amounted to only 193. A few of the enemy actually reached the canal and launched the pontoons. The British troops were too immobile and dispersed to assume the offensive and pursue the retreating Turks on the following day. The Official Historian gives the reasons for this:—"In the first "place, though there were 70,000 troops in Egypt, only the Indian "Infantry Brigades, and not all of them, were highly trained, while it "was necessary to retain troops in Cairo and elsewhere. The only "point in the central sector of the canal defences—the sector attacked "in force—at which there were facilities for moving troops quickly to "the East bank was at the floating bridge at Ismailia, the ferries being "very slow and limited in carrying powers for the purpose. The "mounted troops available were the Imperial Service Brigade and "eight Companies of the Bikanir Camel Corps, and of these certain "squadrons and companies were distributed among the three sectors

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" of the defence." By the evening of February 3rd, 16 squadrons had actually been collected at the bridge, most of them, particularly the Indian troops, far from advanced in training. There were no water convoys in existence. The force was, therefore, useless in both composition and equipment for a counter-stroke beyond the immediate vicinity of the canal. A reconnaissance eastwards was made on the following day, but the Turks made good their retreat.

Kress, in his book, takes great pride in recording that, in selecting the route across the desert in preference to that along the coast, he disregarded all the precedents of history. He attributes his failure to the defection of the Bedouin and the fact that he was not allowed to use the best Turkish troops available, the 10th Division; but he claims that, although his plan failed in its primary object to inflict permanent damage on the canal, it nevertheless was effective in showing that the Turks could bring strong forces with heavy artillery across the desert, and thereby caused anxiety in England and in Egypt and compelled the British to hold the country strongly. He excuses his failure to renew the attack by saying that, had he done so, the remnants of his force would have run a great chance of being surrounded and destroyed. He omits to mention that there had been abnormally heavy rains at the end of 1914, which had filled the ancient cisterns and wells, and thus facilitated his advance along a route which in normal years is almost waterless. General Sir John Maxwell reported that in Egypt the effect of the British success was excellent, in that Turkish prestige had received a severe blow, and all those whose sympathies were with the British, and above all the Egyptian Government, were relieved of fears regarding the situation and confirmed in the attitude they had taken up.

No serious effort was again made against the Canal. Subsequently a few mines were found in the Red Sea, and a Holt liner struck a mine in the Canal and blocked it for a few hours. The hopes of a Nationalist rising in Egypt consequent on a Turkish success on the Canal, which was undoubtedly the object of the expedition in the minds of the Turkish Government and the Turkish C.-in-C., were definitely, and, as it proved, permanently, shattered. It was not until two years after the War ended that the deep-seated unrest in Egypt broke into flame.

During 1915, the Gallipoli Campaign caused a large number of Turkish troops to be withdrawn from Palestine to that theatre. Before they could be spared to return to Palestine in 1916, the defence of the Canal had been made secure by the development of railways, pipe-lines for water supply, transport, and the improvement of communications generally. Egypt was also crowded with troops evacuated from Gallipoli. It was, perhaps, fortunate for Egypt that the Gallipoli Campaign intervened in 1915. The civil population were enriched by the presence of such large numbers of British troops in the country, for Egypt had become the " Levant Base," and was contented. But there was serious trouble now on the Western Frontier, where, thanks to the activities of numerous German and Turkish agents, the adherents of the Senussi were up in arms. This was followed by a rising in Darfur. To the operations on this frontier, in 1915, three

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chapters of the book are devoted. The lesson to be learnt from them is the difference between fighting small wars with fully-trained officers and troops, and fighting them with untrained men unaccustomed to hot climates, with officers unversed in man-and horse-management, and with insufficiency of material and transport. The outstanding feature of these minor operations was the development of the armoured car and of light motor transport, the full value of which experience was reaped afterwards in Mesopotamia and in Palestine.

The proposal to evacuate Gallipoli, towards the close of 1915, was a matter of grave concern to the British authorities in Egypt, for it was certain to set free considerable Turkish forces. That the enemy had not abandoned the idea of another attack on Egypt was shown by his activity in developing the railway system in Palestine during 1915. Sir John Maxwell considered that evacuation would have disastrous results, morally as well as materially, unless Britain struck hard at Turkey elsewhere. It was at his instance that the Alexandretta diversion was once again brought to the fore. The whole problem was referred to the General Staff in London by Lord Kitchener. In Sir George MacMunn's words:—"The General Staff responded "heartily." They took serious objection to the scheme for the following reasons:—

(i) The locality was favourable for the concentration of large Turkish forces (in spite of the fact that the tunnels on the Bagdad Railway were still uncompleted).

(ii) The expedition would have to force its way 25 miles inland; it would then have to hold a perimeter of 50 miles, and for this fortress at least 100,000 infantry would be required.

(iii) Drafts to replace battle casualties and those from exposure would, it was evident, amount to 20 per cent. monthly for the first three months, and 15 per cent. thereafter.

(iv) This expenditure of man-power would not weaken Germany in the main theatre, whereas equal expenditure in France would weaken the Germans to at least an equal degree.

(v) Granting that there was to be a withdrawal from Gallipoli and Macedonia, we should nevertheless for a time be engaged in all three ventures at once, which would cause a dangerous dispersion of military and naval force.

(vi) Eventual withdrawal would be difficult, perhaps impossible.

(vii) The scheme offended against a fundamental principle of strategy: to retain the power of concentrating strength for a great offensive in a decisive theatre of War.

To which, Sir George MacMunn adds:—"The Admiralty also was "inclined to be unfavourable to the scheme, for a new transport route "of 400 miles (that is, from Port Said) would be added to its "responsibilities, and if a landing was contemplated before the complete "evacuation of the Gallipoli Peninsula, there would not be sufficient "small vessels and lighters for the new enterprise."

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General Sir George Monro was not unfavourable to the scheme, and considered that the General Staff exaggerated the difficulties —particularly as regards casualties and drafts. Lord Kitchener considered that there was no alternative to the Ayas Bay scheme but defence of the Suez Canal. Sir John Maxwell's opinion was that, politically, the defence of Egypt in Egypt was undesirable.

While the discussion was in progress the French intervened and made it known that any plan of operations in Syria must be considered jointly by both Governments, and that if any action was taken it must be essentially a French operation, under French Generals and with mainly French troops.

This ended the discussion, for France was not in a position to conduct such an enterprise.

Great Britain had, therefore, no alternative but to prepare to meet a first-class Turkish offensive directed against Egypt.

With the appointment in January, 1916, of General Sir Archibald Murray to the Command in Egypt, the reorganization of the defence scheme to meet the new conditions was taken in hand at once, on the basis that it must be so organized that no enemy could possibly reach the Canal, and that, if attacked, the defenders must be able to make a counter-stroke. He was not content with a purely passive defence, and recommended an immediate advance to a suitable position east of the Qatiya (Katia) Oasis in the north, and the construction of a railway to Qatiya. By so doing, any attempt of the enemy to concentrate a large force in that comparatively well-watered district within two marches of the Canal, would be frustrated, and any forces directed against Egypt would be compelled to concentrate in positions much further east, whence the attack would have to be delivered with a 40-mile desert zone and with bad roads, on the lines of which the water supply was very indifferent, behind them. He was prepared to carry out this scheme with an Army Corps of three Divisions on the Canal, another Division to hold the Qatiya district, and three Mounted Brigades for all purposes. Recognizing the importance of the El Arish-Kossaima zone as the true strategical base for the defence of Egypt, he asked that, if the occupation of El Arish should eventually be practicable, he should be given two more mobile Divisions and another Mounted Brigade to hold it and enable him to undertake an energetic offensive-defence.

This plan was brought into operation at once, and Mounted troops were pushed out east of the Qatiya Oasis to cover the construction of the railway from Qantara and protect the Sappers employed in developing the existing water supply. The position of the covering detachments at Oghratina and Qatiya invited attack, and the Yeomanry suffered a severe reverse at the hands of a strong force of nearly 4,000 Turks with artillery, under the command of Colonel Kress von Kressenstein himself. Three-and-a-half squadrons and half a company of Engineers were surprised (owing to fog) and overwhelmed in the early morning of April 23rd; but the Turks did not press their advantage. The railway progressed without interference until August 4th, when an attack in force, again under Kress, against the Romani position

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was defeated, with a loss of nearly 4,000 prisoners and a mountain battery to the Turks. On this occasion there was no question of surprise, for the Turkish force advanced with great deliberation. The reasons for this were not apparent at the time, but were appreciated when the Mounted troops were launched in pursuit on August 5th and found the Turkish rearguard offering strong resistance. Kress had during his advance taken the precaution to prepare several defensive positions. In the event, these justified the time and labour spent on them, but the delay rendered the element of surprise impossible. The remarkable endurance of the Turks, their marching powers in the deep sand and the great heat of the hot season, their readiness to counter-attack when the opportunity offered, and the rapidity with which they recuperated when they got back to their water and meagre rations, were evidence of the traditional tenacity of the Turk in defence. Romani was a brilliant British success, and marks the end of the campaign against the Canal, but it was disappointing that the enemy should have been able to retire with his force in being and his artillery practically intact, after a complete defeat which had appeared to offer opportunities for his destruction. Sir George MacMunn discusses the causes of his escape at some length, but it boils down to insufficient training of Staffs, Commanders and troops in open warfare. Nevertheless it must not be forgotten that the retreat, especially the withdrawal of the heavy guns, was undoubtedly conducted by Kress and his Staff with great skill.

During the autumn of 1915, the railway and pipe-line for water supply were pushed on with unremitting vigour. Sir Archibald Murray was determined to push on and drive the Turks out of Egyptian territory. His next objective was El Arish, garrisoned by, it was believed, about 1,600 men and well entrenched, and covering all the water in that area. Twenty-five miles south-east of the town, on the banks of the great Wadi El Arish, were further camps at El Magdhaba and Abu Aweigila, protecting the Turkish railhead at El Kossaima.

An advance upon El Arish necessitated the establishment of a very large supply of water at railhead and the concentration of large numbers of camels to carry it forward. Preparations were not complete till the 20th December, 1915, by which date material to carry the railway to Rafah was in sight. On the very day that all was ready for the advance the Turks were reported to be evacuating El Arish. It was occupied by the British on December 21st. Mine-sweeping was at once commenced in the roadstead and the construction of a pier begun. On December 23rd, the first ship from Port Said was landing supplies in boats. The march to El Arish marked the escape from the desert; firm soil was now found in place of the everlasting sand, and patches of cultivation were to be seen. There was, however, to be no halting. The next objectives were Rafah and Magdhaba. The latter was attacked first, on December 23rd, and the position was captured after a brilliant action fought by the Mounted troops under General Chetwode, under whom General Chauvel commanded the Mounted Division, the whole force, including the newly-formed Camel Brigade, being known as the Desert Column.

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"Magdhaba will be remembered," writes Sir George MacMunn, "as "a notable instance of the effective employment of Mounted troops "against isolated fortifications in open country. It proved also the "value of the new Camel Brigade. Less mobile than the Light Horse, "now that the shifting sands of the desert, for use in which it had been "organized, had been left behind, and slower in coming into action, "the dismounted strength of its three battalions almost equalled that "of two Light Horse Brigades. When acting, therefore, with other "mounted troops, it greatly increased their offensive power."

The Turks had been dealt a heavy blow at Magdhaba, 1,272 prisoners being captured, together with four mountain guns and a great quantity of ammunition, but it was impossible to follow up the advantage immediately. The force had to wait for rail and pipe, and it was not until January 8th that the advance was resumed from El Arish, to which place most of the troops had been withdrawn to save transport. At 6.15 a.m. on January 9th, the New Zealanders crossed the frontier of Egypt and Palestine. The action that followed was fought in two continents, Asia and Africa.

Rafah was surrounded on all sides, and, before evening, had been captured after a gallant and stubborn defence with its whole garrison, 1,635 officers and men, of whom 162 were wounded—200 having been killed in addition. The British force withdrew with its prisoners at once, before it could be counter-attacked by the Turkish reinforcements sent up from Shellal and Khan Yunis.

Commenting on the capture of Rafah, Sir George MacMunn writes:—

"The enemy had not learned aright the lesson which had befallen his "detachment at Magdhaba. It can only be supposed that he considered "his position at Rafah to be better and capable of being reinforced "more easily in case of need. That his view was not altogether ill-"founded is shown by the fact that, owing to the arrival of enemy "reinforcements and the lack of water—available only within the "enemy's position or many miles to the rear—the British Commander "(General Chetwode) at one moment proposed to retire before the "fight was won. The margin between success and failure had been "slight." Kress states that his advice (after Romani presumably) was to evacuate Sinai completely, but that the Turkish C.-in-C. (Djemal) for political reasons would not agree to this course. He points out the great advantage possessed in country of this sort by a combatant very strong in mounted troops over an enemy almost without that arm. He exaggerates, however, when he describes the three mounted brigades at Magdhaba as "two English cavalry divisions."

"Sinai was now won. Its occupation may be said to have begun in "early April, 1916. It had been extended by bounds, followed by "steady consolidation and preparation for the next move, except for "the one serious check administered by the enemy at Qatiya. This "method of progress was to continue, its speed always dependent on "that of the railway, and, in rather a less degree, of the pipe-line. But "now the necessity of waiting for the rail and pipe was not the sole bar "to progress. The British Government, in January, 1917, had decided

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"that the necessary reinforcements were not available for a further "advance into Palestine and that the prosecution of operations on "a large scale must be deferred till the autumn of 1917. The general "policy during the summer was to prepare for such a campaign, but "meanwhile—here was the rub—to be ready to release for service in "France one or two Divisions." As a matter of fact, the 42nd Division was ordered to France on January 17th. The enemy in the meanwhile fell back to Gaza and Tell esh Sheria, 14 miles north and north-east of Shellal respectively, thus necessitating a further pause, during which the railway and pipe-line were pressed forward and the troops reorganized into the Eastern Force and Desert Column, the Mounted troops being reorganized into two Divisions, and the infantry provided with wheeled transport in place of camels. Kress states that he would have liked to fight on his strong position at Shellal, but found himself too weak to hold it and at the same time secure the defence of Gaza. Though reinforcements had been promised him by Enver, most of them did not reach him till after the first Battle of Gaza, and he had to order the evacuation of Shellal and all the stores and ammunition collected there. This was completed by the 5th of March.

Before advancing on Gaza, the British had to wait till railhead reached Rafah, which it did on 21st March, followed closely by the pipe-line. The total enemy forces at Gaza, or in a position to intervene, were estimated by G.O.C. Eastern Force, General Dobell, to be two-and-a-half weak Divisions. As a result of the advance along the coast, the British line of communication now overlapped the Turkish. To quote the Official History:—"The question whether the Force should follow the coast-"line, or turn inland towards Auja on the Turkish railway, had already "been discussed and the former alternative had been chosen. Now "that Rafah and (later) Khan Yunis, from which tracks left the coast "route towards Beersheba, had been reached, the problem required "reconsideration. Sir A. Murray, however, again came to the con-"clusion that to turn inland was inadvisable, since by so doing he "would be drawing his L. of C. parallel to the enemy's front, and there "was no technical advantage to be gained by linking up the military "railway with the (Turkish) Central Palestine Railway, either at Beer-"sheba or at Tell esh Sheria. The true line of advance (he decided) was "still along the coast, since the enemy was no less effectually threatened "thereby, while his own L. of C. was more easily protected and railway "construction was more rapid, owing to the absence of gradients. Both "the C.-in-C. and Sir Charles Dobell were concerned lest the enemy "should evacuate Gaza and withdraw out of reach before a blow could "be struck at him. It was, therefore, necessary to act swiftly, and the "only effective action within the immediate power of the British "appeared to be a repetition on a larger scale of the operations which "had proved so successful at Magdhaba and Rafah: that is to say, "a cutting-out expedition against Gaza, after which it might be "necessary temporarily to withdraw the whole force or a part of it to "railhead. Sir A. Murray set three objects before Sir C. Dobell, to "whom the operation was entrusted: to gain the line of the Wadi "Ghazze in order to cover the advance of the railway, to prevent the

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" enemy from withdrawing unmolested, to capture Gaza and its garrison " by a *coup de main.*"

Gaza was attacked on the 26th March, 1917. Two chapters are devoted to the narrative, which is excellent in every way. The battle was within an ace of being as brilliant a victory as Rafah, and had there not been a delay, caused by fog at dawn on 26th March, which hindered reconnaissance and thereby the advance of the infantry, it is probable that the town would have been captured and the force withdrawn before dawn on the 27th, that is to say, before the Turkish reinforcements, two Divisions, which were very slow in coming up and failed to arrive on the 26th, could intervene. As at Rafah, it was a case of " touch and go," but Dame Fortune did not, this time, decide in favour of the British. In the evening, General Chetwode, commanding the Desert Column east and north-east of the town, came to the conclusion that the infantry attack would not succeed on his left, and fearing that his Mounted troops—already in touch with the belated Turkish reinforcements—could not be withdrawn to water their horses without interference, gave the order to General Chauvel to commence a general withdrawal. This was at 6.10 p.m. and the order was given with the concurrence of the G.O.C. Eastern Force, Sir Charles Dobell, whose headquarters were alongside of his at In Seirat, south-east of Gaza. If only Sir Charles Dobell had known the desperate straits of the garrison at that hour, it is probable that the order would not have been given. The tragedy was that the state of the garrison was known not only at Sir A. Murray's forward headquarters on the railway at El Arish, but even at Cairo! Wireless messages exchanged between the Turkish Commander (Major Tiller) in Gaza, and Kress at Sheria, had been deciphered in Cairo but were delayed in transmission and did not reach General Dobell till between 10 and 11 p.m.

The private diary of Major H. P. T. Lefroy, R.E., Wireless Officer attached to Intelligence (E) at Cairo, is quoted in the " Official History." Major Lefroy had the key of the Turkish cipher, picked up all the enemy's messages during the day and telephoned them on, within a quarter-of-an-hour of their being deciphered, to Eastern Force Exchange at Rafah, which was in direct communication with the Battle headquarters of both General Dobell and General Chetwode at In Seirat.

Again to quote the " History " :—" Why these messages did not reach " General Dobell earlier cannot now be determined, as their originals " are not now to be found. The only obvious explanation is that the " advanced headquarters were far from Eastern Force Exchange at " Rafah, that there was heavy pressure on the line forward, that proper " discretion as to the priority of messages was not exercised. The " times of the messages are not known, but there were at least four " which reached Rafah before 6.30 p.m., all of which would have been " of immense value to General Dobell, had they been earlier in his " hands."

The wireless station in Gaza was actually blown up by the Turks, after exchanging farewells with G.H.Q. at Sheria, and receiving orders to destroy all papers and blow up the installation, at 5.40 a.m., on March

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27th, which confirms the information in one of the messages that the Turkish officers had refused on the previous evening to face combat at dawn.

That mistakes were made by subordinate commanders is obvious. The causes of the failure are discussed by Sir George MacMunn on pp. 315–317, but some insight into them is gleaned from a paragraph on p. 289, which anticipates the failure and endeavours to find the cause in the smallness of the Staffs for the number of troops employed. There is also a significant paragraph on the previous page, also anticipatory, in which the Official Historian comments on the advantages of the battle headquarters of the G.O.C. Eastern Force and the G.O.C. Desert Column being alongside of each other, but adds:—"In this there was "advantage, but it was, perhaps, counter-balanced by the fact that the "subordinate of two commanders inevitably feels himself cramped in "his conduct of an action if his superior is 'on top' of him."

After the First Battle of Gaza, the policy of the Government was completely changed, and Sir A. Murray was now urged to advance and capture Jerusalem as soon as possible. This was partly due to the news of British successes in Mesopotamia, but must be in part attributed to the somewhat optimistic tone of Sir A. Murray's first dispatch reporting the action, which apparently led the Government to believe that a victory had been won.

Accordingly, steps were at once taken to hurry forward the railway and provide additional water supplies further north, while the 74th Division was brought up, and with it eight tanks just arrived from England.

Gaza was again attacked on April 17th. Surprise was now out of the question, and it was a case of a frontal attack, for in the three weeks that had elapsed since First Gaza the enemy had reinforced the garrison and constructed a line of redoubts which rendered the outflanking of the left of their position practically impossible, with the troops at Sir A. Murray's disposal. The main effort was made on April 18th, and the battle continued on the 19th, but by the afternoon of that day it was apparent that there was no prospect of success on any part of the front. General Dobell issued orders for the attack to be renewed on the 20th, but was forced by circumstances to abandon the idea, and the ground won was consolidated.

Sir George MacMunn summarizes his comments in the following words:—"Thus ended the second attempt to capture Gaza, and the "most considerable battle yet fought in this theatre. It has none of "the interest of the first attempt, which was practically an encounter "battle with constantly changing situation and ever-unfolding oppor-"tunities on both sides. This was a dogged advance against "imperfectly located entrenchments and in face of fire from heavy "artillery, without adequate support from that arm on the side of the "attackers, an advance which finally lost impetus owing to the lack of "the necessary mechanical support. It needs no comment, save that "it illustrates once more the high quality of Turkish troops in prepared "positions and emphasizes the advantages of defence in areas as opposed

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" to linear defence, at least by day and in clear weather. There were " wide gaps in the Turkish position, but the redoubts were well-sited " for mutual support and permitted the retention of resources for " counter-attack outside the danger zone. Since the Turkish infantry " did not flinch from counter-attack, the result was never in doubt."

The question whether Sir A. Murray was justified in attacking Gaza at all a second time is not discussed. He must have been aware that the enemy had been considerably reinforced after First Gaza, whereas the only addition to his own troops was the 74th Division and eight tanks. Troops have to be trained to work with tanks. The point is whether the C.-in-C. ought not to have resisted the urgent demand of the Government to push on, in the hopes of capturing Jerusalem, without waiting to be reinforced himself. It was probably the eight tanks that turned the balance and induced him to do what he could with what he had got. The only compensation for the failure is, perhaps, that the effort so loyally made diverted Turkish reinforcements from other fronts. To decide that point we have to wait for the second volume.

Space does not allow of much reference to the Arab Revolt against Turkey. It is, however, intimately connected with the advance of Sir A. Murray into Palestine, and its importance was recognized by him. Sir George MacMunn's chapter on the relations of Islam, Arabia and Turkey, and those between Great Britain and the Sherif of Mecca, is a valuable one, and ably summarizes the situation which led to the Arab Revolt. It is satisfactory that the Official Historian recognizes the services of Lieutenant-Colonel—then Captain—T. E. Lawrence (now Aircraftsman Shaw of the R.A.F. in India) to whom, he writes, " much " of the final success of their (Arabs) campaign was due." The " problem " of Rabegh is fully discussed. " The wisdom of the decision " —not to send a British Brigade to Rabegh—can now scarcely be " doubted, strong as were the arguments of those who advocated the " dispatch of troops ; for the presence of a brigade on this unhealthy, " ill-watered shore might have involved the E.E.F. in a serious commit- " ment "—is the comment of the Official Historian, so that Sir William Robertson's opinion is confirmed.

The operations near Aden, in 1915, are lightly touched upon, but, for a general account of affairs in that corner of Arabia during the War, the reader is referred to *The Empire at War*, edited by Sir Charles Lucas, pp. 135–148.

Speaking generally, the form of this volume of the *Official History of the War* follows that adopted in those relating to the Western Front. The Maps and Sketches by Major A. F. Becke, attain the same high standard. The inclusion of panoramic sketches of the country are very helpful in enabling one to realize its nature, although in the case of a comparatively level plain the features are somewhat difficult to discern. In some of them, the impression given is that there could hardly have been any cover at all in the advance.

There is a somewhat different style of comment on the operations in these volumes, which gives the reader the impression that the Editors have been somewhat lenient in accepting amendments and explanations

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to the advanced proofs, which it is customary to circulate confidentially to officers who took part in the operations. Page 200 is a case in point. It is to be hoped that in the matter of criticism the second volume will adhere more closely to the example set by the more experienced Editor of the *Official History of the Operations in France and Flanders.*

H.B-W.

THE PALESTINE CAMPAIGNS.

By Colonel A. P. Wavell.

(Constable, 12s. 6d. net.)

This addition to the series of volumes on *Campaigns and Their Lessons*, edited by Major-General Sir Charles Callwell, K.C.B., following that by Colonel H. de Watteville on *The Waziristan Campaign*, can be confidently recommended to the general reader. It has appeared very opportunely, anticipating Volume I of the "Official History" by a few days. The student has now three good books with which to commence his study, that by Major-General Sir M. G. E. Bowman-Manifold being the third.

In Colonel Wavell's Volume we have, as in General Manifold's, an account of the whole Campaign in Egypt and Palestine by an officer who has had access to the official information on the subject. The book is well written and affords easy reading. It is a relief to re-read it after delving into the detail of the "Official History," for it often summarizes in a page or less the information which must be extracted from perhaps a chapter of the official version. At the same time, sufficient detail is generally given to enable the reader to quote chapter and verse for the statements made.

After reading both Colonel Wavell's Volume and the "Official History," the officer who intends to take up the Campaign for special study, with possibly a view to an examination, will in the last instance do well to refer to the former volume for condensed—and well condensed—epitomes of the political, strategical, or other questions which come up for discussion.

The Volume concludes with a short chapter on "The Lessons of the Campaigns," the subjects discussed being the Value of Mobility, Mechanized Forces, Training and Surprise. This chapter might well be considerably enlarged in a future edition. For instance, to take only one phase of the Campaign—the advance from Qantara to Gaza—lessons that may be drawn include the following:—

(1) Danger of using Cavalry dismounted unless it is absolutely necessary—Romani and Gaza.

(2) Value of close co-operation of R.A.F. and Cavalry. Magdhaba and Rafah.

(3) Value of Mounted troops for long-distance independent missions, especially in a country with no roads. Magdhaba and Rafah.

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(4) Unsoundness of giving the Commander of one formation a call on the troops of another. First Battle of Gaza.
(5) More than one task should not be given to one body of Mounted troops. First Battle of Gaza.
(6) Impossibility of commanding Mounted troops at a distance. First Battle of Gaza.
(7) Raid on Auja-Beersheba Railway justified because the Mounted troops were not thereby kept away from any important operation.

If the title of the Series *Campaigns and Their Lessons*, is correct, and the object is to help officers to dispense with crammers, the consideration of questions such as these is of the greatest value. It entails a thicker volume, some sketches perhaps, and a little greater cost (less than a crammer), but so much has been successfully achieved by Colonel Wavell in the condensing of the mass of material at his disposal that the results of expansion in this direction would probably popularize the book. As it is, the volume does not quite fit the title "Campaigns *and Their Lessons*," and the reviewer has to agree with the verdict of a young officer who has had to study the Campaign—"Rather light!"

The absence of an Index is to be regretted, although there is a good "Table of Contents." The Maps are sufficient, and, for a publication which is not subsidized by public funds, the price, 12s. 6d. net complete with maps, is very moderate. The book is well worth getting, whether one has to study the Campaign or not.

H.B-W.

THE STAFF AND THE STAFF COLLEGE.

By BREVET-MAJOR A. R. GODWIN-AUSTEN, O.B.E., M.C., The South Wales Borderers.

(Constable & Co.) Price 21s.

To many non-unionists "the world's most exclusive trade-union" is from time to time a subject of mild derision or embittered criticism. Others, turning a deaf ear to the pessimists, are struggling in the tide which they hope may wash them up, weary but rejoicing, at the gate marked "In" on the London Road at Camberley.

If the former read, as I trust they will, Major Godwin-Austen's excellent book, they will learn that, after all, the Staff College graduate is a very human person, brought up, at an age when it might be thought that life would be beginning to move with a more dignified and measured tread, in a school in which hard work, hard riding and hard play are sauced with a *joie de vivre* worthy of the junior school next door.

The other class will surely be stirred to greater efforts in order that they may join in the good days awaiting them: incidentally they will absorb much good meat against examination day.

It is hardly too much to say that every officer should read this book as an essential part of his military education, for in it the author has

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traced clearly and in the most attractive manner the growth of the organization which was not only responsible for the outstanding efficiency of our small Expeditionary Force in 1914, for its secret and rapid dispatch overseas, but, in spite of the heavy losses of trained personnel, was yet capable of forming the foundations of the tremendously expanded staff required by the great armies of later years, firm foundations to which the success of the fine operations of the summer of 1918 bore witness.

Major Godwin-Austen has told his tale in a quite admirable manner, for although he has included all the *Army Orders* which form the main milestones on the road of progress for the last 120 years, he has sandwiched the dry bread of official memoranda so cunningly with the juiciest meat of anecdote, and infused the whole story so well with that rare good spirit of *camaraderie* and humour in work and play, the best quality of the two best years of one's life, that there is never a dull page in the book.

What will strike the reader most, perhaps, is the way in which he has made, with a wealth of apt stories, all these historical characters stand out alive, vivid, human, natural as if one knew them in person. Le Marchant, founder of the Staff College, or Senior Department of the R.M.C., as it was at first, "student and fighting soldier, teacher and administrator; an upright gentleman; a man of the world, of high moral character." General Jarry, kindly, courteous old Frenchman, educated and thoughtful soldier, an enthusiastic exponent of military sketching: Hamley, humorous writer, eminent military historian, combining "exceptional ability with a love of every kind of sport, fine horsemanship and reputation for bravery in the field," but not one to encourage students to differ from him in opinion!

Many more sidelights we are given on great men of the past: Wellington, inveighing against "educated" soldiers, yet surrounding himself with the men of High Wycombe; the Prince Consort, strong friend to the Staff College, for which it may be said he gave his life: the old Duke, first energetically supporting reforms in Staff and Staff College, and then, in later years, the devil he had raised pushing him faster and faster towards uncharted shoals, unable to stem the tide, thanks to the energies and wider outlook of Wolseley and his men; all these the author brings to life for us.

Finally, he recaptures the high spirit of the Drag, best of all institutions, breeding-ground of many a lifelong friendship, rare training and test of soldierly qualities, humour, grit, patience, a good heart.

As "teacher" might say: "Good work."

R.L.B.

"THE MECHANIZATION OF WAR."

By VICTOR WALLACE GERMAINS ("A Rifleman").

(Sifton Praed.) Price 8s. 6d.

This book, which includes an instructive "Foreword" by Major-General Sir Frederick Maurice, is a useful contribution to the ever-

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increasing volume of post-war literature on the subject of tanks and of the mechanization of the Army in general, and should be read by those who have studied recent works on these matters by Colonel Fuller and Captain Liddell Hart.

Mr. Germains deals firstly with the use of tanks and the problem of their design, and then makes a vigorous onslaught on those who seek to establish a new "Science of War." He next passes to the problem of how to escape from trench warfare, and concludes with a chapter on the policy that should be adopted for the future organization of our Army.

Supporting his arguments by the opinions of many well-known authorities, the author contends that the popular theory, that the "deadlock" on the Western Front in the late War was only finally solved by the use of tanks, has little foundation in fact. This deadlock, he asserts, was due to a general balance in military resources and a general standardization in methods, training, and equipment, *not* to a breakdown in military technique, and he points out that where such a general standardization did not exist there was no stalemate, *e.g.*, the battles of Tannenberg, the Masurian Lakes, and the break-through at Gorlice.

What really solved the deadlock on the Western Front was, in Mr. Germains' opinion, the arrival of vast numbers of American troops, which had great effect on the morale of the German Army, besides freeing considerable numbers of French and British troops from quiet sections of the line.

The chapters dealing with the value of tanks during the War are, on the whole, very convincing, although occasionally Mr. Germains appears to have slightly over-reached himself in the search for facts to suit his opinions.

It cannot be denied that, as he says, some German attacks made *without* tanks were as successful as Allied attacks with them, and that our successful tank attacks owed much to the co-operation of all the other arms and to surprise being possible.

Mr. Germains is, however, inclined to underestimate the moral effect of tanks, and it seems probable that his opinion on this point would be different if he had had the mischance to be charged by one in the open, with nothing but a rifle in his hand and a pair of 8 m.p.h. legs to move him out of the way. He suggests that it should be no more difficult for infantry with a rifle firing armour-piercing bullets to stand up to a tank attack, than for a big game hunter to face a charging elephant. One is inclined to wonder whether he would maintain this argument if the elephant's trunk, instead of merely emitting hot air, were belching forth machine-gun bullets at the rate of 300 to the minute.

In dealing with tank design, the author shows that we have entered on the phase which began in sea warfare with the development of the "ironclad," the struggle between armour and projectile, in which the tank, having *all* its surface exposed to view and attack, is at a disadvantage as compared with the warship.

The conclusion at which Mr. Germains appears to arrive is that all Governments will be equally alert against surprise by new forms of tanks, and that, since it is infinitely cheaper and simpler to build anti-tank weapons than to build tanks, the chance of bringing off tank "surprises"

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are by no means favourable. Later on in the book he admits, however, that tanks in limited numbers and for certain purposes are necessary.

As Sir Frederick Maurice points out in the "Foreword," the history of war shows clearly that no one weapon is for long supreme: the reply to it is soon found. This, then, renders it all the more necessary, while making every endeavour to equip troops with the best possible weapons, to rely upon correct principles rather than particular methods.

With regard to the so-called "Science of War," the author maintains that there is no such thing, and that what is often popularly given this name is in reality a "Technique of War." It is absurd, he suggests, to postulate "Laws of War," and he points out that victory can often be gained by deliberately disregarding so-called "Laws." A "Military Pelmanism," Mr. Germains remarks, is a sure road to disaster.

The majority of military students will no doubt agree in the main with the author's somewhat drastic criticisms of the would-be creators of a Science of War. As Sir Frederick Maurice points out, "there is nothing new in this attempt; the military pedants of the eighteenth century were more skilled in it than are their imitators of this year of grace. The *artist* Napoleon swept aside their theories as an autumn gale sweeps away the leaves that fall. Belief in a Science of War took Mack to Ulm."

In the chapter on "How to Escape from Trench Warfare," it is pointed out that, however swift a mechanized force may be, however rapidly it may manœuvre, it has to have lines of supply, and cannot live on the country (a point often slurred over by ardent protagonists of the tank), and it has no smashing power. Mr. Germains writes—"It has no heavy artillery, it cannot charge forts. Thus it is necessary for us to bring, or threaten to bring, *smashing power* against the enemy's great railway centres. By this means we shall fix him to his ground, and afford to the mechanized column the chance to "drive" at his flank and rear. The issue of such fighting will depend on questions of leadership, numbers and power. If the enemy is equal or superior to us in such elements, it is hopeless to think of decisive victory. But given superiority on our side, the combination of *weight* and *pace* affords the only real prospect of making a break with trench warfare."

It is doubtless true that no war can be won without fighting, and that to hope to win a battle by manœuvre without fighting would be futile. At the same time, to lay down that a mechanized column can have no *smashing* power seems open to argument. Mr. Germains evidently visualizes such a column as composed solely of vehicles like the Vickers tank, whereas most readers when picturing a mechanized column will include mechanized artillery, mechanically transported "infantry," supply vehicles, etc., which will undoubtedly be necessary in some form or other to enable a mechanized column to fulfil its functions.

In the last chapter the author outlines our military commitments, and exposes fairly accurately our military unpreparedness as compared with pre-war days. He lays down somewhat arbitrarily that an Expeditionary Force of 12 Divisions, plus ancillary troops, represents the minimum necessary to fulfil our obligations under the Locarno Treaty, and that we must be prepared to support this by a further 12 at very short notice,

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otherwise it would mean stalemate, and a war which might last for years.

The conclusion that Mr. Germains arrives at is that mechanization of a large national army is not a practical proposition, and that, therefore, while we are active in experimental work, and while we may be justified in producing a small mechanized army, the latter must be supported by a great national army in time of war if it is to do anything really useful. He therefore suggests that greater efforts should be made to build up military reserves. The problem of training and expanding the Territorial Army should be tackled by making the Regular Army work closer with the Territorial Army—the former acting, in fact, as an educational agency for the latter. He suggests that short-service men should be taken into the Regular Army to qualify as instructors in drill, musketry, etc., and that on expiry of their colour service they should be given non-commissioned rank and posted to Territorial battalions instead of to the Army Reserve.

Mr. Germains also attacks the Cardwell system, alleging that it is wasteful and illogical in time of peace. He suggests (without referring to the hardships and administrative difficulties it would involve) a system in threes, whereby only half a battalion would be maintained at home for every battalion abroad. It is maintained that by this system the other half-battalion would be available for training short-service recruits and building up a reserve.

The author appears to overlook the fact that the battalions now stationed at home on the Cardwell system enable us to provide only an Expeditionary Force of 5 Divisions. If the home battalions were, as he suggests, cut down to half-battalions, it is difficult to see how any Expeditionary Force at all could be organized, or even how provision could be made for situations such as that which now exists in China. Mr. Germains rightly considers that a European war is our biggest commitment, but he appears to ignore the fact that, whereas only perhaps twice in a century are we faced with a European war, small wars and disturbances occur at far more frequent intervals, and have to be dealt with by a standing army.

It seems doubtful whether Mr. Germains' solution is the correct one, although it will be generally agreed that, as Sir Frederick Maurice points out, our little Regular Army has not solved all or even most of our probable military problems. It is but the advanced guard of our national army. "Let us make the advanced guard as mobile as may be, but in doing so we must not neglect the main body."

G.N.M.

PSYCHOLOGY AND THE SOLDIER.

By F. C. BARTLETT, M.A.

(Cambridge University Press.) 7s. 6d.

This book is a selection from lectures delivered at Cambridge by the author, who is Reader in Experimental Psychology and Director of the Psychological Laboratory of the University of Cambridge. The Preface

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acknowledges the help of Brig.-Gen. E. W. Costello, V.C., C.M.G., C.V.O., D.S.O., Director of Military Studies at the University of Cambridge.

With the progress of material science, the burdens laid upon the officer increase daily—but at the root of all things lies the *man;* he is the one fundamental factor which does not change, or changes very slowly. It is curious, therefore, that in the multiplicity of text-books an officer has to study but little direct assistance is given him in this study of the "fundamental factor." Not every officer is a born leader of men, and surely a wise study of psychology would prove of assistance to most. The following quotation from the General Introduction to the books puts the case clearly: "If the Duke of Wellington had been accused of being a psychologist, his reply would probably have been brief but very emphatic. On one occasion, however, he was trying to state the qualities of a great Captain. 'One must understand,' he remarked, 'the mechanism and power of the individual soldier, then that of a company, or battalion, or brigade, and so on, before one can venture to group divisions or move an army.' Personal courage is necessary and valuable, but is by itself utterly inadequate. In discussing Sir John Moore, Wellington said: 'He was as brave as his own sword, but he did not know what men could do, or could not do.'"

There, in a nutshell, is the case for the application of psychological study to the problems of building and training an army. For it is the psychologist's business to try to understand "the mechanism and power" of the individual, to know "what men can do and what they cannot do, and to learn how human conduct is governed."

Part one of the book deals with "Choosing and Training the Recruit," and the chapter headings will give the scope: "Testing the Special Senses," "Testing Intelligence," "Tests of Special Abilities," "Training bodily skill," "Practice and Motives in training bodily skill," "The Study of Fatigue."

Part two deals with "Leadership, Discipline and *Morale*," and it is this part which is likely, perhaps, to make the most immediate appeal on first reading.

Incidentally it is a pity that the word "morale" is not treated as an English word and so written, instead of as "*morale*" or "*moral*." Surely, as laid down in *Modern English Usage*, the time has arrived to adopt a standard and straightforward way of writing this ill-treated word.

Discipline is defined as "enforced obedience to external authority," morale as "obedience to an authority which comes from inside the man himself." This is a restricted use of the word morale, which in its wider sense means "the mental state of a group of men," such as an army. The whole discussion is interesting and helpful.

Leaders also are classified under three different types, and their characteristics and limitations and different methods of leading are illuminating. A further chapter deals with "morale with special reference to group games."

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Part three is on "Mental Health and Disease in Warfare." The normal reactions, of the individual and the group, to war conditions are discussed. Then follow chapters on the hysterias produced by the late War, which were sometimes classed under the general name of "shell-shock."

Altogether, this book may be recommended to the reading of all officers, with the hope that it may lead to further individual study of this important subject. As the author puts it, "it is most desirable that any person who takes up a professional career should have some lively interest, outside of the mere routine work of his profession, but if possible bearing upon it, which he can prosecute throughout his life. Such an interest, though it be no more than what is called a hobby, is in most cases just what is needed to keep a man keen and alert, to prevent him from stagnating, from falling into hopeless ruts." Such an interest, he suggests, is given by the study of the problems dealt with in this book, and by the study generally of the men with whom the officer deals in his daily work.

P.H.K.

WASHINGTON: AN ESSAY IN THE REMOVAL OF WHITEWASH.

PIOUS LIBELS.

Reviewed by E. B. OSBORN.

GEORGE WASHINGTON, THE IMAGE AND THE MAN. By W. E. Woodward. (Jonathan Cape.) 15s. net.

(Reprinted from *The Morning Post*.)

The Mayor of Chicago and all the other hundred-per-cent. American patriots will surely detect the "snoot" of George the Third on every page of Mr. Woodward's vivid biography. Indeed, we should not be surprised if the book were burnt alive on the lake-front of their midway metropolis, that huge paradise of boodlers and bootleggers! Not only does Mr. Woodward scrape off the various coats of whitewash from the historic effigy of the first President (an executive officer, by the way, created in the image of George the Third), but he also does his best to destroy the popular myth of a righteous Revolution carried out by pious whole-hearted patriots. Let us, first of all, consider the new background he paints into his portrait of the Father of his Country.

"The revolutionary movement," he points out, "was started by the merchants and the lawyers. It was purely a commercial dispute which had nothing to do with personal liberty. To make their grievances more alarming to the British Government, the aggrieved merchants organized the common people—the voteless and the landless—into mobs which made it impossible for the British to carry on the peaceful administration of affairs or to protect life and property."

The American working classes were in a perpetual state of impoverish-

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ment. Nothing had been done to alleviate their hard lot, and in the Courts a working man had practically no standing when he was opposed to his employer or any other person of property or social position. There was a time when the oppressed common people threatened to capture the whole revolutionary movement, and they would certainly have done so but for the powerful opposition of Washington and other leaders of the colonial aristocracy, who were able to thrust them down and keep them down. When the British rule came to an end, the working classes were worse off than they had ever been.

American history is now being re-written by American scholars, who seek the truth in a spirit of scientific disinterestedness, and nothing "Big Bill Thompson" and men like him can say or do will prevent the completion of this task. The popular conception of the "Boston Tea-Party" is one of the many myths which have been swept away by truth-seeking historians. The East India Company had decided to ship tea direct to America in its own vessels, to establish its own warehouses there, and to sell direct to the retailers. This plan, if carried out, would have eliminated the tea smugglers and other middlemen, and have provided the working classes with a necessity of life—they then drank hot tea at all three meals, if and when they could afford it—at a much reduced price. There was nothing patriotic in the successful campaign at Boston, and elsewhere, against cheap tea. The tea smugglers, who occupied a position similar to the liquor smugglers of to-day, were responsible for its success. What happened was just what would happen if the Anti-Prohibition movement were to become so strong that Prohibition would be really in danger. "Does any sensible person," asks Mr. Woodward, "think that the bootleggers of America would stand by in idle indifference, and see their trade swept away, and their families brought to ruin? Dollars by the million would pour into the Prohibition treasury, lobbies would besiege Congress, the Ku Klux would be set to work, and in the remote districts the more aggressive opponents of Prohibition would probably be decorated with tar and feathers."

The American Revolution was a squalid business from first to last. The picturesque legends of "Embattled Farmers" at Bunker Hill vanish as we read of the efforts to suppress mutiny in the revolutionary armies—in particular, as we contemplate the fate of the Pennsylvanian soldiers, who refused to march south unless they were paid "in real, not ideal, money." The twelve ringleaders were shot by their particular friends and messmates. Washington himself had little belief in patriots and patriotism. "I know patriotism exists," he wrote, "but I will venture to assert that a great and lasting war can never be supported on this principle alone. It must be aided by a prospect of interest or some reward."

Mr. Woodward ruthlessly destroys all the Washington legends invented to give a moral tone to the Revolution, which have been taught to generation after generation of American school children. The story of the axe and the cherry-tree has long been abandoned by historians, and the myth of exceptional vitality which shows us Washington engaged in solitary prayer in the woods at Valley Forge, making it very clear that he wanted God's help in giving the British a

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good hiding, is proved to be a preposterous fabrication. "In direct opposition to the pious Valley Forge legend," writes his biographer, "is the fact that Washington was never known to pray in church; that his own pastor said he never knelt when there were prayers; that he never took Communion, even in the church of which he was a member." And there is no historical authority for the literary composition known as "Washington's Prayer," which has appeared in innumerable papers on the anniversary of his birthday, and will, no doubt, continue to appear.

But the removal of the several thick coats of whitewash leaves a character, strong and sufficient to itself and scornful of picturesque illusions, which stands head-and-shoulders above his contemporaries. Even when we know his weaknesses, we must needs respect this strange combination of an aristocrat and a backwoodsman. Among the corrupt wire-pullers and war profiteers and noisy demagogues of his period his figure is splendid, almost heroical, by contrast. He was not a great soldier; his conception of an army for his purpose was unsuited to the colonial character, and he missed the opportunity of creating a mobile force of marksmen, which would have anticipated the methods of the Boers. But, despite constant ill-health and the haunting obsession that he came of a short-lived race, he finished the work he took up and earned the "tranquil enjoyments" (a typical Washington phrase) of his later life at Mount Vernon. Perhaps Mr. Woodward is right in summing him up as "the American common denominator, the average man deified and raised to the *n*th power."

(CHEMICAL WARFARE) DER CHEMISCHE KRIEG.

By DR. RUDOLF HANSLIAN; 2nd revised and essentially enlarged Edition. Large 8vo, 411 pages and an Appendix of 31 plates; 3 coloured maps and 111 photographs and sketches. (E. S. Mittler und Sohn, Berlin, S.W.68, Kochstrasse, 1927.)

Favourable reception of this work at home and abroad caused the first edition to be exhausted in a few months. So much new material had meanwhile become available that the author, instead of acceding to the many demands for an immediate re-issue, felt himself constrained to re-write the book. It has now become an encyclopædia on gas-warfare, which should be in the hands of everyone who, like the author, is convinced that gas-warfare, having arrived, has come to stay, and of anyone, if such there be, who has yet to come to this conclusion.

As motto of the book might well have been chosen Admiral Mahan's dictum that every new weapon of war has invariably been first called barbaric, and finally universally adopted. Its object is stated in the Preface—to lead the reader to a recognition of the future possibilities of gas and its presumable influence on war. The method chosen of attaining this object is "the collection of valuable material out of the fullness

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of the existing and continually increasing gas-literature of foreign countries." To this end the author has compiled a bibliography of close on 300 books, pamphlets and articles, to most of which he refers and from some of which he makes extracts, often of considerable length.

The works most frequently referred to or quoted from are:—

Fries and West, "Chemical Warfare." (McGraw Hill, New York.)
British official "Manual on the Use of Smoke."
Vedder, Lt.-Col., "Medical Aspects of Chemical Warfare." (Wilkins, Baltimore.)
Bloch, Chef d'escadron; "La Guerre Chimique." (Berger-Levrault, Paris.)
British official "History of the Great War: Medical Services."
Kerschbaum: "Die Gaskampfmittel." (Mittler und Sohn, Berlin.)
"Chemical Warfare" (Magazine of the C.W. School, Edgewood, U.S.A.).
Fischmann: "Gasowaja Woina." (Soviet Govt. publication, Moscow.)
Lefebore, Major: "The Riddle of the Rhine." (New York.)
Heigl, Major: "Die künstliche Vernebelung." (Vienna.)
Haber: "Die Chemie im Kriege." (Julius Springer, Berlin.)
French official, "Instruction pour la protection contre les gaz de combat."
Dopter: "Lectures at the Ecole Supérieure de Guerre." (Paris.)
Farrow: "Gas Warfare." (Dutton, New York.)
Worrall, Lt.-Col.: "Smoke Tactics." (Gale & Polden.)

The foregoing provide together about one-half the total number of references in the text, which amount to nearly 600 in all. There are, in addition to these, 300 cross-references, over fifty other footnotes, and no less than three separate indexes—one technical, one geographical and one of proper names. Indications are thus not lacking of considerable pains having been taken in compiling the book. Further, the author in his Foreword complains of the trouble caused in gas-literature by incorrect examples due to misprints, or more often, to mistranslations. It is the more surprising, therefore, to find that very little care has been expended in getting English titles of books and articles correct. Altogether, over thirty such mistakes have been counted, and English readers are liable, in consequence, to judge unfavourably of the general accuracy of the work. "Wielemans," on p. 89, can hardly be passed as the name of a British general, while "Wilougsby," although recognizable, is too strange to be true. On p. 139 reference is made to our "6th" Army, while on p. 90, Hill 60, of undying memory, is helped towards oblivion by being called Hill "160."

Figures and formulæ are not always happy. The metre and yard vary in relationship within limits as wide as 450 : 550 (on p. 349), and 210 : 200 (on p. 343). On p. 61, both the formulæ given for the Chlorarsines, Lewisite B and Lewisite C, appear to be wrong, as they do not check with Lewisite A, Chlorvinyl Dichlorarsine, Cl. CH : CH. As Cl_2.

As regards the correctness of translation, Sir P. Chetwode, speaking at the R.U.S.I. on Air Attacks on London, comes in for particularly bad treatment in this respect, two of his remarks having obviously been made into "pie."

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There must be so many Germans who know English well that there can be very little excuse for such mistranslations, especially in a book where forty per cent. of all the references are to English and American works.

These are blemishes on an otherwise excellent compilation.

F.A.I.

TASCHENBUCH DER TANKS, ERGÄNZUNGSBAND, 1927.

By MAJOR HEIGL.

(J. F. Lehmann's Verlag, Munich.) Price 8 marks.

The mass of new material which Major Heigl has gathered since his *Taschenbuch der Tanks* appeared last year has forced him to bring out a supplementary volume. No more convincing evidence could be offered of the importance attributed to the tank by the military powers, and of its immense possibilities in future warfare. The book contains:

Part 1.—Technical Progress, Tracks (steel and rubber), Semi-Track, Wheel-cum-Track; 40 pages, 16 photos and 4 plates.

Part 2.—New Tanks; England, 28 pp.; Morris-Martel (photos and plates); Carden-Loyd (photos of two types—caterpillar and wheel-cum-tracks; also of 2-man tank); Vickers W.C.T.; Light Vickers Mk. I (photos and plates); Light Vickers Mk. IA (photo); Light Vickers Mk. II (photo); Heavy Vickers (photos and plates); France, 9 pp.: the Char 2c (photo and silhouette); the new light tank (photos). Besides England and France, many other countries receive notice, and in addition to photos of the U.S.A. Medium M 21 and Medium M 22, and of the Italian Light Fiats, there are full descriptions, photos, silhouettes and elevations of the Russian Fiat Half-tank, the Swedish M 21, the new Spanish light tank and the famous Czecho-Slovakian K.H. 50.

Part 3.—Modern tank-tactics. This part starts with tank-tactics of 1918, illustrated by extracts from reports of the battle of Cambrai, and of the battle of the 8th August, and gives an account of the arrangements for the Hush-operation at Middelkerke. It deals with tanks in defence and tank patrols, gives French manœuvre examples of combined attack by the largest break-through tanks and light tanks, examples of tank-action in Morocco and in Syria; Rapid tanks; tanks used independently; English manœuvre examples (chiefly from Capt. Liddell-Hart); anti-tank weapons; the battle of the future; the R.R. Vickers; strategic mobility.

There follow two useful lists, a bibliography of tank literature in various languages, and the tabulated principal details of over one hundred of the latest tanks of all nations.

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This book, like the *Taschenbuch der Tanks*, to which it is a supplement, is more than a revelation of what has already been achieved. It is also an earnest of wonders to come. The next volume will be eagerly awaited.

F.A.I.

NOTES ON THE VARIOUS ARMS OF THE SERVICE.

By CAPTAIN A. M. BARRETT, M.C., Essex Regiment.

(Gale & Polden, Ltd.) Price 1s.

This is an attempt to condense down to thirty-two pages the information given in various text-books on the characteristics of the various arms of the service and their employment " in the five principal tactical operations of war." A Foreword says that these Notes should be of much assistance to those officers and N.C.O.s of the Territorial Army who are unable to find time to study all our numerous official text-books and memoranda from cover to cover ; but the amount of study and the number of books required to obtain such information as is contained in the pamphlet are not really great. The elementary details and *rôles* of the various arms are adequately covered, but as is so often the case in this form of " cramming notes," the pamphlet suffers severely from slipshod phrasing, which, at times, renders passages difficult to understand. This is particularly the case in the Artillery paragraphs. One cannot help feeling that a diet of fresh meat is more healthy and pleasant than one of meat lozenges, however they are shaped and flavoured, even if meals do take longer to consume.

H.G.E.

PHYSICS IN INDUSTRY.

Lectures delivered before the Institute of Physics. Vol. V. By H. E. WIMPERIS, O.B.E., M.A., F.R.AE.S. (Director of Physical Research to the Air Ministry), and F. E. SMITH, C.B., C.B.E., D.SC., F.R.S. (Director of Scientific Research to the Admiralty).

(Oxford University Press, London : Humphrey Milford.) Price 2s. 6d.

This book comprises Lectures X and XI of the series.

Lecture X, by Mr. H. E. Wimperis, is upon the relationship of Physics to Aeronautics.

It appears that experiments made hitherto have had as their object the ascertainment of the lift and drag coefficients of aero-foils : they are usually carried out in wind channels upon models ; the reader is left to imagine the details of the experiments and the precise nature of the apparatus.

Many points are touched upon, but so superficially, and so many

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technical aeronautic terms are used that the Lecture can scarcely be of use or interest to the average physicist. Probably it has been devised for those directly concerned with aviation experiments.

Lecture XI, by Dr. F. E. Smith, is upon the relationship of Physics to Navigation.

An introduction describes the evolution of the various instruments used in navigation, ending with a description of the gyroscopic compass.

Then follows an account of the various methods of navigation in foggy weather near land, the approximate position of the ship being supposed known.

An accurate chart being available, the taking of soundings appears one of the most reliable ways of finding the ship's position. Soundings can quickly and accurately be made by the Admiralty echo sounder, of which a description is given. This instrument is fixed near the keel, and enables the interval of time between the emission of a sound and the reception of the echo from the sea bottom to be measured, thus giving the depth.

For navigation in a narrow channel, when landmarks are invisible, the leader cable is a device of interest. This is an insulated cable, laid along the bottom of the channel, through which is passed an alternating current. The vessel to be navigated is provided with electro-magnetic apparatus, on either beam, of such sensitivity as to record unequal effects unless the ship is symmetrically over the cable.

This device seems open to the objection that a pair of ships following the cable might very easily collide.

Consideration for the amount of space available forbids description of other interesting methods.

The Lecture concludes with a summary of the methods employed for determining the distance of icebergs in foggy weather, but, in the opinion of the lecturer, sufficiently reliable apparatus is still lacking.

The printing and diagrams are admirably clear and reflect credit upon Messrs. Humphrey Milford, the publishers to the Oxford University.

J.M.W.

NEW GEODETIC TABLES.—R.G.S. TECHNICAL SERIES No. 4.

Could that celebrated warrior, Brigadier Gérard, revisit the scenes of his exploits, he would, so one may think, be not a little astonished to discover that there existed soldiers to whom the exact figure of the earth was a material consideration.

Face to face indeed with the complexities of modern war, one can imagine even his stout heart failing, and see him making all haste to regain once more the security of the grave.

It is possible that not a few R.E. officers, if called upon to deal at short notice with some of those Geodetic problems, with which the military surveyor has occasionally to grapple, would fully appreciate his sentiments.

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Chief, perhaps, among these problems, are those which arise from the practice, by surveyors of different lands, of assigning varying dimensions to the earth on which we live.

In order to compute his triangulation, the surveyor must assume some values for the shape and size of the body on which his measures are made. These values always require subsequent amendment, but, once adopted, correction is troublesome and is seldom urgent enough to justify the expense involved.

It thus happens that the surveys of the world are projected on a great variety of figures of the Spheroid, and the hapless British military surveyor may find himself constrained to use any one of them—a necessity which, until the production of the present pamphlet, might have involved him in severe computation.

Geodetic Tables are given in the *Text Book of Topographical Surveying* for Clarke's 1858 figure, which the recently published book on Survey Computations repeats in slightly different form.

The Ordnance Survey uses Airy's figure, and the Survey of India Everest's, each with its own set of Tables, but there are, of course, many others in current use in other parts of the world.

The Tables under review are for Clarke's 1880 figure, and for that adopted by the International Geodetic Union in 1924.

They contain some novel features, the most interesting of which is the device by which comparison can be made of these with other figures.

The preparation of Tables for any new figure is by this means very greatly simplified.

The Tables themselves are preceded by a preface and introduction giving full particulars of the method of use, and of the circumstances which led to their preparation.

Bound in the form of a handy pamphlet, and admirably printed in excellent clear type (there are unfortunately one or two misprints in the Introduction), the work is one for which the authors may well receive the grateful thanks of all whose duties deal with Survey and Geodesy in the Field.

M.N.M.

QUANTITIES OF MATERIALS AND COSTS PER SQUARE FOOT OF FLOOR FOR HIGHWAY AND ELECTRIC-RAILWAY LONG-SPAN SUSPENSION BRIDGES.

Paper No. 1649 of the American Society of Civil Engineers.

By J. A. L. WADDELL, M.AM.SOC.C.E.

The author claims that this paper will " Enable any engineer of good, " general experience to compute, in two or three hours, when full pre- " liminary data are furnished, the total cost of any projected highway " or electric-railway or combined highway and electric-railway suspen- " sion bridge and its approaches."

All calculations have been reduced to simple curves for bridges from 00 to 5000 ft. span.

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Although Royal Engineers are unlikely to be called upon to build permanent bridges of such dimensions, there is much matter of interest in the assumptions and method of working out costs and design.

There are also interesting discussions by eminent American Civil Engineers on such subjects as light-weight floor design, the "elastic" and "deflection" theories for calculations and effect of these in design, of stiffening trusses, and the theory of anchorages.

These discussions and the author's summing-up are well worthy of study.

H.A.B.

THE ELECTRICAL EQUIPMENT OF AUTOMOBILES.

By STANLEY PARKER SMITH, D.SC., M.I.E.E., A.M.INST., C.E.

(Published by Chapman & Hall, Ltd.) Price 5s. net.

This small book embodies the material given in a course of lectures intended to furnish essentially practical information required by those engaged in the manufacture, maintenance, repair and running of automobiles.

A knowledge of the fundamental laws of Electricity and Magnetism is assumed, and the book is an attempt to give in plain terms a technical description of the action of essential parts of the electrical equipment of automobiles. Complications involving no fundamental principle are not discussed, as the author considers that a sound understanding of basic parts will enable the reader to follow the working of more complicated systems. Throughout, consideration has been given to proper maintenance, and stress is laid upon the methodical location of faults.

The book deals, in order, with storage batteries, the action of electric motors and generators, the starting motor, the three-brush generator, ignition systems, and wiring systems, and is illustrated with sketches and diagrams to explain the principles set out.

With the assistance of this handbook and makers' diagrams and instructions, there should be no difficulty in keeping the electrical equipment of automobiles in good order, and in finding out what is wrong in case of trouble.

R.M.

ELEMENTARY ELECTRICAL ENGINEERING.

By ALBERT E. CLAYTON and HERBERT J. SHELLEY.

(Longmans, Green & Co., Ltd.) Price 7s. 6d.

There is nothing particularly new in this book, but it is written very clearly, the subject matter on D.C. Machinery and A.C. Theory being particularly well explained.

A useful Table of the properties of insulating materials is given in Chapter XV.

Well worth the price—7s. 6d.

R.M.

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THE ELEMENTS OF TELEPHONE TRANSMISSION.

By H. H. HARRISON.

(Longmans, Green & Co.) Price 5s.

Although written primarily for telephone engineers, a large portion of the book will be found very useful by power engineers. The book is divided into four chapters: the first giving a résumé of elementary mathematical theory required by electrical engineers, and the second an elementary theory of alternating currents. The whole of these two chapters, which comprise about half the book, are directly applicable to the transmission of electrical energy for power purposes. The third chapter deals with wave transmission and will assist the power engineer when studying transient phenomena due to faults and switching. The last chapter deals with practical telephone circuit conditions.

A few printer's errors are noticed, but considering the large amount of mathematics in the book, the errors are insignificant.

The treatment of "skin effect," given on pp. 56–58, is interesting and helpful, but not very conclusive. If a conductor is divided up into a large number of strands, it will be clear, from page 56, that the inductance of individual strands increases from a minimum at the circumference to a maximum at the centre. This causes a non-uniform current distribution in the conductor and, therefore, an increase in its effective resistance. The effect becomes more important as the frequency increases, owing to the increase of the ratio of reactance to resistance, the latter being relatively large compared with the reactance at the lower frequencies.

To secure approximate uniform current distribution it is not sufficient simply to strand the conductor. The strands must be insulated individually, and, further, they must be plaited so that each strand has the same mean distance from the centre as all the other strands.

The last two lines on page 58 are liable to mislead the beginner. Iron wire has been used extensively for telephone lines and is quite satisfactory up to, say, 20–30 miles for ordinary military purposes.

Lines 10, 11 and 12 on page 67 are correct, but the treatment given does not constitute adequate proof.

In the practical example given on page 79, para. 10, the spacing of the wires should have been given.

The treatment of the subject is, on the whole, quite clear, but it is unfortunate that the same notation has not been adhered to throughout, *e.g.*, V is used indifferently for velocity of propagation and for voltage. Capacity is denoted sometimes by K and sometimes by C, Impedence sometimes by Z and at others by I, thus confusing it with current. It is surely time that writers accustomed themselves to the symbols recommended by the International Electro-technical Commission.

The book can be recommended to anyone intending to take up the study of Electrical Engineering seriously, whether for power or signal purposes. It is good value for money.

W.M.

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ELEMENTS OF MACHINE DESIGN.

By W. C. UNWIN, LL.D., F.R.S., and P. L. MELLANBY, D.SC. (Longmans, Green & Co., Ltd.) PART I, New Edition. Price 15s.

This book is an introduction to machine design, and is intended to supply students with the necessary principles and formulæ which are afterwards to be used in the actual design work. The book opens with a chapter on ferrous and non-ferrous metals used in machine construction with Tables of tensile strength and elongations. This is followed by a summary of the straining action experienced in machines, and a comprehensive survey of the resistance of structures to these strains. Much of this chapter, *e.g.*, bending moments of beams under load, is old ground to all R.E. officers, but the calculations for Boiler Shells and Leaf Springs are interesting. The author then deals with the calculations for strength of various machine details, in each case discussing the problem and arriving at a logical or, in some cases, an empirical formula as a basis of design. Riveted joints, screw threads, bolts and keys are fully discussed. The chapter on journals contains a summary of the principles of lubrication and figures of recent tests and experiments. A large number of sketches or drawings are given of various types of bearings, and recommended proportions are stated. Finally, one hundred and seventy pages are devoted to power transmission by friction gearing, geared wheels, belts, ropes and chains. The theory of geared teeth is worked out, and sample calculations for strength and wear are given. There is a very full consideration of driving by belts; the results obtained show that the usual Army practice as laid down in *M.E.*, *Vol.* I, is on the safe side.

The book has a wider scope than is normally required from R.E. officers, but can be recommended for all E. and M. officers as a book of reference. No more knowledge of the general principles of mechanics is needed from the reader than all R.E. officers possess.

A.P.A.L.

SIMPLE METHODS OF SURVEYING FROM AIR PHOTOGRAPHS.

By Lieutenant M. Hotine, R.E. (H.M.S.O. 1927. Price 3s. 6d.)

This little book will be welcomed by all who are interested in Air Survey, for it is the first of its kind which deals clearly and simply with a practical method of making a medium-scale map from overlapping air photos. The theory of the principles involved is confined to an Appendix, and there may be many who will leave this Appendix unread and thankfully say "We accept the radial assumption—let us confine ourselves to the body of the book and see how to get on with the job." Others, on the other hand, may think that this "radial assumption" is open to criticism, but it must be remembered that the practical results of surveys based on the methods described are extraordinarily good, and that the "proof of the pudding is in the eating."

Roughly, the underlying principle of the method is that directions from the "principal point" of any photo are all true directions, provided that there has been no excessive tilt. With photos overlapping 60% it is

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possible to pick up points of detail which appear on three successive photos, and by intersection and resection the " minor control plot " as it is called is carried through the whole strip of overlapping photos.

This plot is then brought to correct scale by reference to two control points whose distance apart is known, having been fixed by ground methods.

Contouring is done on the actual photos by means of the topographical stereoscope, spot heights being provided by ground methods as a control.

There is no question that the book would be easier to follow if it were possible to have a strip of overlapping air photos and a stereoscope in front of one, and actually to carry out the various processes of orienting the principal point bases, plotting the minor control, and contouring, etc., step by step. Without following each excellently written description of what to do in practice in this way, one suffers from the same difficulty as would occur if one was to read a text-book on how to play chess without having a board and chess men with which to carry out the moves described.

Chapter II, pages 17–29, makes most interesting reading, and describes how " height traverses " with batteries of aneroid barometers can be carried out. Such aneroid traverses are, of course, perfectly applicable to surveys made wholly by ground methods, and all surveyors will be interested.

Chapter V describes a most ingenious method of " carrying on " with the minor control plot should any pair of photographs fall short of a 50% overlap. It is based on sound principles, but there is, of course, a limit to this makeshift, and it cannot be too strongly emphasized that over 50% is the overlap required. One hopes that this knowledge will be widely disseminated, especially amongst pilots who undertake the flying for such photography. To fly level, to fly straight, and to be certain that your photos are really overlapping 50% or more is what is required of you. The days when your skill was judged by the fewness of the photos that you found it necessary to take to cover a given area are gone.

P.K.B.

MAGAZINES.

COAST ARTILLERY JOURNAL.

The Military Notes of the Journal for September have an interesting account of the great importance attached to bayonet training in the Japanese Army, comparing it to the apparent lack of the bayonet spirit in the American Forces.

The Japanese Regulations stress this spirit in the most stirring terms :—

" No machine will ever be invented that can withstand the bayonet " courageously and intelligently directed by the human brain and the " human hand. Handle it as your fathers did their swords, and rely

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" on it as they relied on their swords. . . . the final issue will be met " man to man. Then the bayonet will be supreme and the spirit of " the bayonet will be the spirit of the winner . . . the Field-Marshal " will count his bayonets and measure the strength of his forces by that " count. . . . The enemy cannot overthrow our plans until he has " overthrown our infantry and their bayonets, and we can only over- " throw the enemy by the fearless use of the same bayonets. . . . " The most brilliant exploits of the artillery, cavalry, air service and " all the other arms cannot save the day if the man with the bayonet " fails. . . . The cold steel has, from time immemorial, been the weapon " of the Japanese soldier ; with it, and with it alone, he has preserved " his country and made his glorious record as a fighting man. . . . " The abdomen of the enemy is the first objective, and it is the place " easiest to hit and easiest pierced with the exception of the throat. " To the throat, however, is hard to get home ; the throat is the part " of the enemy's body which he can most easily remove from the line " of the bayonet thrust. The soldier will do well, therefore, to run at " his foe at top speed, shouting his battle cry, in order to weaken the " spirit of the enemy, and thrust home to the stomach with all his " might and with the full strength of his weapon and his arm. Usually " the first thrust will be successful. If not, a second thrust should be " made from either side of the foe, and at once, as no time should be " lost in fencing. The man who thrusts the surest and the quickest, " and thrusts repeatedly, is the man who wins the bayonet fight."

An observer relates that the long thrust is used to the exclusion of all other forms of attack, and the butt is seldom if ever brought into play. This is probably to make up for the short stature of the average Japanese infantryman. No time is lost in fencing. The attack is made in pairs as far as possible, efforts being made to gain the enemy's left side and aim at the lower abdomen.

A large part of the time of instruction in bayonet training is devoted to personal combat ; the winner of each combat meets man after man until he himself is defeated. The skilled bayonet man is looked up to with something akin to awe by his fellow soldiers, and is frequently excused various duties.

Night-manœuvres are always carried out with fixed bayonets, in order to accustom men to handling their rifles in the darkness under these conditions.

The Japanese bayonet course has several unique features. A trench about twelve feet deep and eight feet wide has to be crossed at the charge: to climb on the far side, one man bends over while his companion climbs upon his back and scrambles over the top with his rifle still in his hand.

To assault an unbroken fifty-foot belt of barbed wire, the first men up to it throw themselves flat on to it face downwards and lay their rifles over it in front of them ; their fellows jump on their backs and in turn throw themselves as far as possible into the wire with rifle extended so as to elongate the slender bridge as much as possible, and enable their comrades to pass across as soon and as quickly as they can, with the pur-

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pose of making a lodgement. Meanwhile, others begin cutting the wire out from the bottom so as to form a free passage.

Men who are ready to do this in cold blood, even though plain wire is used for training instead of barbed wire, must indeed be animated by the burning patriotism and religion which is said to be the base of the Japanese cult of Bushido.

When the infantry recruit first joins, and when the reservist rejoins the colours, his rifle, with bayonet fixed, is personally delivered to him by the Regimental Commander with his own hands, with the admonition to guard it and keep it unsullied as his own soul. To say that the bayonet is venerated by the Japanese infantry soldier is not considered too bold a statement.

D.M.F.H.

REVUE MILITAIRE SUISSE.

(1927. Nos. 1 to 6 inclusive.)

L'armée espagnole dans sa dernière campagne riffaine. Colonel de Diesbach gives an interesting account of a visit paid by him to Melilla, in May, 1926, on the termination of the successful operations carried out by General San Jurio against the Riff tribes; the African troops of the Spanish Army created an extremely favourable impression on his mind, and he was apparently somewhat surprised to find that their equipment was quite up-to-date.

Défense économique et nationale. Under this title, Lieutenant E. Naef deals with the question of motor spirits. He points out that the production of petrol is no longer merely an industrial problem, but one which, in view of the rapid mechanization of modern armies, is also a matter closely affecting national defence; in consequence, an attempt should be made to discover a "carburant national," suitable for all types of engines propelled by motor spirits, which is not derived from petroleum oils. A brief review is given of some of the recent researches carried out with this object in view.

Autour des leçons de la guerre. The article is a contribution from General J. Rouquerol; in it he indicates some of the errors to be avoided by those who attempt to deduce lessons from past campaigns for application in future wars.

A l'est ou à l'ouest. Colonel Feyler makes instructive comments on an article by the Austrian General Goiginger, published in the fourth part of the 1927 issue of the *Schweizerische Monatschrift für Offiziere aller Waffen*, wherein the latter discusses the problem which confronted the Great General Staff when, in 1914, Germany found herself committed to a "war on two fronts." General Goiginger approves, on military grounds, with the plan of campaign adopted in August, 1914, by the Germans. Colonel Feyler investigates the situation and shows that, in reaching his conclusions, General Goiginger has assumed without any justification whatever that Great Britain and Belgium would necessarily

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in any case have been participants in August, 1914, in a war between Germany, and France and Russia fighting as Allies. Colonel Feyler points out that, had there been no invasion of Belgium, the problem before the Great General Staff would, on the immediate outbreak of the war, have been a very different one and might well have been solved in a different way. With only the French and Russian Armies to contend with on the Western Front, the line of contact between the opposing forces would have been reduced from the 400 km., involved by bringing Belgium into the war, to 250 km., and the Germans would have had 70 divisions to deal with instead of 80. In these circumstances, a defensive war on her Western Frontier and an offensive war on her Eastern Frontier at the opening of hostilities might, in all probability, have crowned Germany's effort with success.

W.A.J.O'M.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1927. TOME II. NOS. 1 to 3 INCLUSIVE.)

Les opérations de l'armée belge. Events of October 20th, 21st and 22nd, 1914, are dealt with in these numbers of the *Bulletin*. The contents of an Intelligence Report, issued from the Belgian G.Q.G. at 7 p.m., on October 20th, are set out in No. 1; it shows that by this time the Belgian High Command had ascertained generally the composition of the German Fourth Army and had an accurate knowledge of the enemy force operating against the Belgian Front. An account is given in No. 1 of the strong attacks directed by the Germans against Nieuport and Dixmude on October 20th: a sketch map, inserted in the text, shows the dispositions of the Belgian Army on this date and also the Fronts held by the formations of the British and French Armies operating in Flanders—the line held at the beginning of the day, as well as that to which they had fallen back by the evening, are both marked; the various formations of the German Army in contact with the Allies in this region are also shown on the map.

The opening phase of the Battle of the Yser is dealt with in No. 2, and the text of the instructions issued by the O.C., 2nd Bn. Belgian Engineers, for carrying out the inundation of the region east of Nieuport, between the Nieuport and Yser canals, is given. Action was taken on these instructions on the evening of October 21st, and a sketch map, inserted in the text, has marked on it the limits of the inundation actually carried out. Another sketch map shows the Fronts held by the Belgian Army, the French troops on its right, and the B.E.F., on the morning of October 21st, and the changes which had taken place before nightfall on the portion of this line south of Dixmude. The text of the Operation Order, issued at 6 p.m., on October 21st, from the Belgian G.Q.G., then at Furnes, is set out in No. 2: on this date the Germans directed a violent bombardment against the Belgians, and carried out a strong offensive against the central portion of their Front. The situation on the Belgian Front, as known at the G.Q.G. (Furnes) at

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6.30 p.m. on the 21st, is given; it was causing the Belgian High Command much concern. Reinforcements, in the shape of the French 42nd Division, arrived during the day in the region of Ghyvelde, Bray Dunes, Coxyde and La Panne, and its commander, General Grosetti, proceeded to Furnes, where he arrived at 7.20 p.m. Differences arose at once as to how the 42nd Division should be employed; the French General intimated his intention to move his troops to the region of Nieuport, whereas the Belgian High Command desired that the French troops should be available for utilization on that part of the Belgian Front which the needs of the moment might dictate. The situation became somewhat more embarrassing when it was learnt that in the orders, issued by General Foch on the 21st, in relation to the constitution of the "Détachement d'Armée de Belgique," under General D'Urbal, directions were given for the following troops to be placed in the groups under General Bidon—this group linked up the left of the B.E.F. with the right of the Belgian Army—viz., the Fusilier Marine Brigade, 42nd Division and the 9th Corps (this Corps was then being transferred from the Aisne to Flanders). General Joffre had visited the Belgian G.Q.G. at Furnes during the day and had discussed the situation with King Albert; the latter apparently was not put in possession of information as to the intentions of the French G.Q.G. as to the manner in which the 42nd Division should be utilized, and neither the French generalissimo nor King Albert raised any question as to any fresh plans in connection with the employment of the Belgian Army.

The events of October 22nd are dealt with in No. 3 of the *Bulletin*. The situations north of Nieuport and at Dixmude, at about 8 a.m. on the 22nd, are shown on sketch maps; the line, from Nieuport to the French Frontier, held on the evening of the 22nd, is marked on a third sketch map. The Germans on this day surprised the Belgian troops near Tervaete and forced a passage across the Yser, inflicting serious losses on the defenders; a grave situation was thus created on the Belgian Front. The Germans on this day also launched an offensive against the French right; the French gained a small success at one point, but had eventually to fall back, and at the end of the day were holding the western bank of the canal between Knocke and Steenstraat. The German attack against the French right involved the British left; the 1st Division had to give ground and for a short time a critical situation existed, owing to the penetration by the enemy of the Allied Front at the point of junction of the British and French troops. The timely arrival of support enabled the situation to be restored. The French 17th Division (9th Corps) had detrained at Cassel on the previous day, and was moved up to Ypres by motor transport during the 22nd. A German radio message had been tapped by the B.E.F. on the previous day; it contained information as to the objectives of the German Fourth Army. The contents of this message were communicated to the Belgian High Command, and are set out in the *Bulletin*. The text of the Operation Orders, issued by the Commander of the "Détachement d'Armée de Belgique," at 7 p.m., on the 22nd, and by the Belgian G.Q.G. at 2.15 a.m., on the 23rd, are also given in No. 3.

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Problème de la Sûreté. The sixth of a series of articles under the above title, by Major Barthelemi, of the Belgian General Staff, is published in No. 1. The original article contains interesting comments on projects prepared by von Moltke in 1867 and 1870 for the invasion of France, and a comparison of the arrangements actually made in August, 1870, by the belligerents at the outbreak of the Franco-German War to cover their respective Armies during the mobilization and concentration periods. The opening phase of the 1870 War is also briefly described.

Le Principe de la Bataille. The two concluding parts (XI and XII) of the article under this title, by Major Jobe, are published in Nos. 1 and 2. Part XI deals with the 1918 Campaign of the Great War; the general situation at the beginning of 1918 is briefly sketched out; Ludendorff's plan of campaign is discussed; the German offensives in Picardy, on the Lys, on the Aisne, on the Oise and in the Champagne region, are described in outline and commented upon. An outline map is provided on which are shown the line held by the Entente troops on March 21st, 1918, and the territory gained by the Germans during their offensives.

Part XII deals with the final phases of the Great War, beginning with the counter-offensive launched by the Western Allies on July 18th, and ending with the general advance from the Sea to the Meuse which compelled the Germans to seek terms of peace. The lessons of the campaign are discussed, and, in conclusion, Major Jobe points out that the study of campaigns from the date of the Battle of Cannæ to the present time demonstrates that the aim of the stragetist has throughout the ages remained unchanged, but the methods employed by him to attain his aim have continued to vary from century to century, and, as there is no finality in inventions which affect the equipment and the other matters bearing on the mobility of armies, novel methods will still have to be devised in the future by the strategist to meet the changing conditions of the time. The eventual objective of every skilful commander still consists in the complete encirclement of the forces opposed to him. However, the Great War has shown that a new factor has been introduced into the problem in the future; strongly entrenched fronts with inaccessible flanks are likely to be met with in big wars. In these circumstances, strategic flanks cannot be turned by manœuvre alone, and it has, therefore, become necessary to fight costly battles in order to break through the enemy's front, as a preliminary to cutting him off from his line of communications, for the purpose of attaining the ultimate strategic aim of the High Command.

W.A.J.O'M.

REVUE DU GÉNIE MILITAIRE.

(*August.*)—This number contains the first part of an article of considerable interest, by Colonel Clément Grandcourt, entitled, "Fortress Warfare on the Russian Front." It gives a short history of the Russian

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system of fortification in Poland and a detailed account of the attack and capture of Novo Georgievsk. The importance of this place, known to the Poles as Modlin, which lies at the junction of the Vistula and Narev, was realized by Napoleon, in 1807, who made there a quadruple *tête de pont*. The works sketched out by the French were amplified twenty-four years later by Nicholas I. After 1870, the place was strengthened by Todleben. Plans for modernizing the fortress were drawn up in 1911, but were far from complete in 1914. Novo Georgievsk stands on the railway between Danzig and Warsaw; its fall was essential to the Germans for the prosecution of their great offensive in the summer of 1915.

(*September.*)—The above article is completed in this number. By August 10th, 1915, the place had been invested. The north-east sector only was subjected to heavy artillery fire. One fort surrendered on the morning of the 17th, and, during the following night, the whole of the forts in the principal line in the north-east sector were abandoned. By an order of the Governor, on the afternoon of the 19th, the permanent works in the north-west sector were also abandoned, and, on the 20th, the fortress capitulated. Amongst other material, 1,200 guns and 200 tons of copper fell into the hands of the Germans. Thirty Generals and more than 85,000 officers and men were taken prisoners. The fall of the fortress was due far more to the pusillanimity of the Governor than to any other cause. Of 33 forts, three were taken by assault, one surrendered, and the remainder were abandoned. From the strategical point of view, the defence of Novo Georgievsk had served to deny the use of the Danzig-Warsaw Railway to the Germans for some twelve days, and had prevented 50,000 Germans from taking part in the pursuit of the Russian Field Armies during one month; a small result for a fortress as strong as Verdun.

An article on raft bridges, by General Normand, gives examples of bridges made from rafts, starting with the passage of the Rhine by Hannibal and ending with bridges made during the Great War.

Chef de Bataillon Chambaud describes a bridge of boats for heavy loads made over the Rhine by the 12th Engineer Regiment, between the 5th and 16th October, 1925. The bridge was 88 metres long, of which 52 metres were floating. The boats took up practically the whole of the waterway.

The *October* number contains an article by General Caloni, entitled, "The Preparation of the Field of Battle of April 16th, 1917," in which he describes the preparations, from an engineering point of view, carried out in the area in rear of the line Hurtebise—Beaumont-sur-Vesle occupied by the 5th Army.

The preparations started with a reorganization of the Engineer Command. Experience gained in the battles on the Somme had shown the necessity of the Engineer Command taking a more active part in the supply of material and transportation in the advanced zone. On January 4th, 1917, G.H.Q. ordered the suppression of the "Directions

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des étapes et services" (D.E.S.), their functions being allotted to a fourth branch in each army staff so far as supply of material and transportation was concerned, and to a "Direction des étapes" (D.E.), forming part of the staff of the Commander of the group of Armies, so far as the organization of the L. of C. and exploitation of local resources were concerned.

The D.E.S. was abolished on January 16th in the 5th Army, and the services of water and roads from the technical point of view; the Engineer park of the Army and the exploitation of forestry were handed over to the Engineer branch of the Army. At the same time all Engineer units came under the command of the Engineer-in-Chief.

The article describes the Engineer work under the following heads:—

R.E. Parks and Depôts.
Works.
Preparation of the Area of the Attacks.
Communications.
Water Supply.
Electrical Services.

In spite of difficulties, due to the weather, all preparations were completed by April 16th.

An article called "Engineering in the Levant," by Lieutenant-Colonel Vergnon, describes certain works carried out by the French Engineers in Syria, namely:—

(1) The narrow-gauge railway (60 cm.) from Ghazalé on the Hedjaz Railway to Sonéida, constructed in order to facilitate the conduct of operations in the Djebel Druze.
(2) The reconstruction of the citadel of Sonéida, which had been burnt down after its evacuation in September, 1925.

There are several photographs and plans.

In the *November* number there is an article, "Notes on Construction in the Western Sahara," by Captain Ricard. In it he gives a brief account of the communications, inhabitants and natural resources of the country. It is interesting to note that the subterranean canal called "foggara," which is a common feature of the country, appears to be identical with the "karez" of Central Asia. The staple building-material is round brick, and the only tree from which timber for building purposes can be obtained is the palm tree. The method of construction with these materials is described in detail.

A.H.B.

REVUE MILITAIRE FRANÇAISE.

(*October*, 1927).—In the second instalment of *Douaumont pendant l'occupation allemande*, General Rouquerol describes, firstly, the relief of the 5th Brandenburg Division by the 2nd Bavarian Division on 23rd May, 1916, and, secondly, the measures taken to improve the defences of the fort. The Bavarians had to attack almost as they carried out their

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relief, and were successful in regaining the forward trenches lost a day or two earlier, but suffered very heavily in the process. The conditions about this time must have been almost indescribable ; but by continuous labour, especially by pioneer units formed for the purpose, the sector was improved till a reasonable degree of comfort was reached before the autumn. Unfortunately for the Germans, the defensive work outside the fort received less attention than the work inside.

Colonel Lucas begins an article entitled *Des qualités du chef* in this number. He points out that, according to the regulations, the duties of a commander are to " conceive, prepare and conduct " operations in his own formation. It is quite clear that conception is mainly the duty of the higher, conducting that of the lower, commander ; and the writer goes on to discuss in detail the various qualities which different commanders should possess, those commanding divisions and lower formations being regarded as the lower commanders, as it is impossible for the commander of a formation higher than a division to be actually known to his own troops. In this instalment, qualities which are essential to both types of commander are considered.

Cheval et moteur is an interesting and important article by Commandant Janssen, on the subject of mechanization. He discusses the advantages and disadvantages of H.T. and M.T., and comes to the conclusion that the horse is still the most important means of draught within fighting units, whereas the introduction of M.T. for supply services would produce a saving of personnel equal to three divisions in the French Army. He points out, however, that the introduction of mechanization is useless unless the nation can supply its own fuel ; but apparently successful experiments in this direction have been carried out. Actual armoured fighting vehicles are not considered in this article, which refers mainly to types of M.T. which exist in peace-time.

The second instalment of Commandants Desmazes' and Naoumovitch's article, *Les victoires serbes en* 1914, describes the crossing of the Drina by the Austrians, and the concentration of the Serbian Third and Second Armies on the battle front before the Austrians had made real headway. Part of the Second Army covered one hundred kilometres in two days, and the mobility of the Serbs, compared with the slowness of movement of the Austrians, compensated for the advantage which the latter held in possessing superior forces and the initiative.

Capitaine Andrieux' *La répression des fautes militaires dans les armées romaines* is of historical interest. He points out how the Romans, like ourselves, realized the need for military law, and describes briefly the main crimes and penalties. Where the Roman system failed, as compared with our own, was in the combination of prosecutor and judge, as represented by the tribune.

(*November*, 1927).—The third instalment of General Rouquerol's *Douaumont pendant l'occupation allemande* describes the French attack of October 22nd, 1916, and the succeeding days. Apparently the Germans were short of ammunition at this time, and the French artillery practically won the victory before a single infantryman moved forward. To follow the narrative, reference to the map given in the preceding number is necessary.

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Commandants Desmazes and Naoumovitch, in the third instalment of *Les victoires serbes en* 1914, describe the defeat of the Austrian Fifth Army during the period August 16th–19th and its retreat over the Drina. Although the Austrians were really in superior numbers, they allowed a whole Army, the Sixth, to be masked by a small Serbian force. The Serbs were, therefore, able to concentrate superior numbers against the Austrian Fifth Army, which was heavily defeated. The operations are illustrated by a useful sketch map.

Colonel Lucas completes his article, *Des qualités du chef*, in this number. After discussing the application of intellectual, professional and moral qualities, first to higher, then to lower, commanders, he concludes by pointing out how the responsibility of the highest commanders tends to increase, rather than decrease, and how a sense of proportion between the various qualities is required. We all know Napoleon's maxim on the study of the campaigns of the great commanders of history, but to command successfully we must know also how to apply this study.

Pour apprendre l'art de la guerre, by General Camon, is an article which should be of value to Staff College candidates. The writer considers three phases of the operations of war, viz. (a) the effect of the political situation on the plan of campaign ; (b) the preparation of a plan which takes into consideration the counter-moves which may be expected from the enemy ; and (c) the distribution of troops in the theatre of war. These are illustrated by examples from Napoleon's campaigns and amplified from the Emperor's own writings.

Les troupes de montagne dans l'armée allemande, by X . . ., describes the present organization of " mountain " troops in the German Army. Before the Great War, no troops were specially trained for fighting in mountainous districts, but, by 1917, six Divisions had been given special, instruction, and it was these who were instrumental in the Italian disaster at Caporetto. Full details are given of the present organization and the type of training is indicated. It is, of course, quite clear that these troops form part of the nucleus of a national army, not part of the internal security army which was laid down at the Treaty of Versailles.

General Rouquerol completes *Douaumont pendant l'occupation allemande* in this number. Apparently, the fort was evacuated by the Germans on account of the general withdrawal of the line on this part of the front. It was the French bombardment which really achieved the success ; although the fort had resisted the deluge of shell so far, on October 23rd terrible havoc was caused by 400 millimetre projectiles, used for the first time at Douaumont. The evacuation of the fort was begun on the next day. In his comments, the writer draws attention to the jealousy between the Bavarians and the Prussians, which began in 1870 and was still apparent during the Great War.

Etude sur nos procédés défensifs, by Général Brossé, is an important article on the present-day trend of thought with regard to defensive positions. The writer considers that the brilliant success of General Gourand's Army in July, 1918, has given the impression that his method is necessarily the correct one for the defence to adopt. In practice, as is pointed out, General Gourand's success was due to the factor of surprise

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which he employed so effectively. If all defensive positions are occupied on the same lines, the surprise factor vanishes, and the dice are loaded on the side of the attack. The writer considers, and with reason, that there is no golden rule for the adoption of a defensive position, but that the first, second, third or fourth line of defence should be the one selected for protracted resistance, according to circumstances.

La garde prussienne les 21 et 22 août 1914, by Commandant Maury, begins in this number. The account is of the operations of the 2nd Division of the Guard Corps at the passage of the Sambre. The operations are described in considerable detail, but the most interesting feature is the appearance of Ludendorff as Quartermaster-General of the Second German Army. Although von Bülow, the Army Commander, had ordered his Corps to halt on 21st August, owing to the Armies on the flanks not being up, Ludendorff, who was sent forward on a reconnaissance, had no hesitation in ordering the Guard Corps to attack when it appeared that the crossing of the river might be forced.

Infanterie et chars de combat, by Colonel Velpry, is a discussion of the employment of tanks in conjunction with infantry. He demonstrates what is accepted in our own Army, that if tanks are used they should be employed in considerable numbers and not in little packets. From certain examples from 1918, he concludes that about a company of tanks is required on a battalion front of attack, or one battalion to a division, a proportion corresponding to that which is aimed at in our own Army.

Au Maroc français en 1925, by Capitaines Lacau and Montjean, begins in this number. This instalment deals with the special conditions (climate, terrain, etc.) which apply to war in Morocco, and the situation when Abdul Krim's power was at its height. These are described in considerable detail and illustrated by sketch maps. The instalment concludes with the arrival of Marshal Pétain in August, 1925, to take charge of the operations.

In *Le salon de l'automobile en* 1927, Lieutenant-Colonel Doumenc criticizes the tendency of French manufacturers to concentrate on luxury and six-cylinder cars of various designs, instead of turning to the American methods of mass production and provision of cars for the majority of the people. The value of mass production in war and the need for home-made fuel are emphasized by the writer.

La centenaire de la bataille de Navarin, by Colonel de Nerciat, is a short historical sketch of the liberation of Greece at Navarino, a hundred years ago.

H.A.J.P.

MILITÄRWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(MAY–JUNE, 1927, CONTINUED.)

Technical Weapons and Services, by Lt.-Col. Paschek. War technics were too little appreciated before the World-War in favour of ruthlessly mobile tactics. The numerically few technical troops in the Austrian Field Army in 1914 included, for constructional and destructional work,

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Pioneers (comprising Engineers, Sappers, Bridgers, etc.) and for communication services, the following:—railway troops, inland waterway personnel, and the signal service.

During the Great War, troops for chemical warfare were added to the first group; while separate branches were formed for road-making, and for heavy bridging. Other branches were generalized (building services) or separated (camouflage, H.T. electricity, etc.). In position-warfare, both formations and equipment increased enormously. As regards transport, the chief increase took place in motor transport, while an air transport service was also got under way.

It is peculiar to technical troops that, more than any other, they are dependent upon equipment and materials. Many tool-columns, depôts and dumps are the visible signs of this dependence.

Unlike the case of military railways, where engineers are responsible for traffic as well as for construction and maintenance, there is the case of the roads which the engineers construct and maintain, while the traffic is in the hands of the transport service. Thus various interactions result. The connection with the fighting arms has become more and more intimate, as evidenced by battalion pioneers, technical services in close fighting, chemical warfare, motor transport, tactical transport by lorry and aeroplane, and, finally, the signal service in the battle area. We should in future say not "The Combined Arms," but the "Combined Arms and Services." There is much work to be done in organization. Finally, close co-operation with science is indispensable, and with national and private technical organizations.

The Engineers. The demand for an organization as simple and uniform as possible, and easily administered, is sound. Against such an organization work technical demands of every kind. The controversial question as to whether there shall be one kind of engineers or several tends, among the nations with unlimited equipment, to be answered in the latter sense. Otherwise, training and organization of employment prove altogether too difficult. One naturally tries to keep the Universal Engineer as far as possible, and, indeed, upon the conquered nations he has been directly forced by the limitation of numbers. A good deal has been taken off the shoulders of the Engineers by permanently adding regimental pioneers to the different arms.

Regimental Pioneers should resemble army pioneers as much as possible. In the infantry and cyclists, their allotment should be on a unit basis, *e.g.*, to each infantry regiment (English, brigade) there is a company of pioneers, which, however, is only detached when occasion demands. It carries long- and short-handled tools, wire-cutters, explosives, small flame-projectors, gas and smoke-bombs, camouflage material, inflatable sacks, collapsible boats, material for obstacles, lighting equipment and signal stores. The proportion of portable equipment to equipment conveyable in first-line transport is carefully tried out, so as to relieve the man of as much weight as possible. In case of necessity the company has allotted to it some of the divisional transport which is usually earmarked for the regimental pioneers. The Cyclist Battalion could include a section, and the Divisional Squadron a group of pioneers, principally

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with demolition and bridging material. It is worth considering whether the G.O.C., R.A. should not have a section for building O.P.s and light bridges. Technical cares are removed from the Cavalry by their own pioneer squadrons, or, in the case of Light Mounted Brigades, (or Divisions), by their cyclist companies. Here and there it is better to give the much-overburdened infantry regiment (English, brigade) a company of pioneers to itself, but the closer the different arms are accustomed to work together, the less important this becomes.

Army Pioneers. Engineer units are both included in the higher formations, and reserved for allotment by A.H.Q. and G.H.Q. They differ according to the nature of their technical work and in organization and distribution.

(*A*) *General.*

(*a*) The Pioneer is essentially the earth, stone, concrete and explosive worker for fortifications and communications ; also carpenter and smith for military bridges and fortifications.

(*b*) The work of the Sappers and Miners is what their name indicates.

(*c*) The Bridger is chiefly a waterman for crossings, for military and temporary bridges. Even if the first two services (*a*) and (*b*) are combined, this service should be kept separate.

Besides the above, in countries where motor transport is highly developed, there is likely to be :—

(*d*) A road-construction service, which, if necessary, will serve for railway construction.

For this work it is no longer necessary to have, as for the services (*a*) to (*c*), only fully trained and physically fit ; on the contrary, apart from the foreman and other leaders, men under instruction, physically defective and of old categories will do. This is even more the case in :—

(*e*) The general construction (auxiliary) service ;

so that Army pioneers and Bridgers, who are few in numbers and difficult to train, should be relieved and set free for other work. The good pioneer, and especially the pioneer N.C.O., is becoming rarer and more precious. In the highly-industrialized state, skilled workmen fall off considerably. In addition to this, military engineers are, to a great extent, trained by drills and exercises for which short service becomes less and less sufficient. The number of completely-trained engineer units is cut down, equipment is simplified, one tries for better methods of working, for less-trained men with foremen and leaders, and strives, finally, as far as possible, to replace the man by the machine. Hence the necessity for organized auxiliary services.

The labour of the fighting troops themselves can also be reckoned under this head especially that of reserve infantry formations.

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(*B*) *Special.*

(1) With the fighting arms (*a*) chemical warfare, gas and smoke, (*b*) technical close-quarter fighting, flame-throwers and mining, (*c*) search-lights, (*d*) camouflage, (*e*) river warfare, navigation and mining.

(2) Other services (*a*) Electrical and power machinery and the service of workshops (loads, boring, sawing, cutting, sweating, ramming, etc.), lighting, cooking and heating, H.T. obstacles, ventilators, pumps, arrangements for drinking-water, photography, (*b*) construction and running of light railways and telferage, construction of broad-gauge railways, (*c*) heavy iron bridges.

(*C*) *Replacements.*

(1) Reserve depôts for personnel.

(2) Tool and equipment columns, and store depôts, with personnel.

(*To be continued.*)

Permanent Fortification, by Colonel Schneck. The development of permanent fortification is traced from the abandonment of the bastioned trace for the system of girdle-fortresses consequent on the introduction of rifled ordnance, and the parts played by Brialmont, Tilschkert and Vogel, von Brunner, von Leithner, Sauer, von Schumann and Mougin are shown. The Author says that, generally speaking, permanent fortification has suffered from two main evils, (1) that its objects have been very expensive of attainment, (2) that progress in armaments has been only to a limited extent capable of anticipation or met by reconstruction. Consequently, at the beginning of the Great War, not a single state was in possession of a system of permanent fortification which consistently met requirements. The position of Austro-Hungary, with about 3,500 miles of frontier, nearly three-quarters of which bordered on presumptive enemies, was particularly unfavourable.

An examination is then undertaken of the *rôle* played by permanent fortification during the Great War in each of the nations, starting with Austro-Hungary, which is dealt with under four headings (*a*) Galicia, (*b*) the mountain front (Carinthia and Tyrol), (*c*) the Balkan front, (*d*) the coast.

The conclusion reached is that the permanent fortifications of the country, in spite of their being not up-to-date in many respects, completely fulfilled their essential task of gaining time.

(*To be continued.*)

The Crossing of Rivers under Cover of Smoke. General Mischek, of the Czecho-Slovakian Army, has written a book dealing with fights for rivers (*Boj o Reky*), which the Austrian reviewer considers should become a standard work on the subject. He gives the following extract:—

"The already extremely difficult undertaking of a river crossing becomes, against an enemy strong in artillery, so much more difficult that the cover afforded by smoke is essential. Smoke is equally necessary if

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attacks by hostile aeroplanes are to be expected, against which it affords, often, the only protection. A smoke-screen is required for the place of preparation as well as for the place of crossing, and great care is necessary in selecting the positions for the smoke-forming materials. The production of smoke on a large scale must be carried out under tactical leadership in order to guarantee success and to avoid anything prejudicial to one's own troops. In order to deceive the enemy, neighbouring sectors must also have smoke-screens put down. Since smoke discharged from the bank will often not be able to cover the river in its entire breadth, smoke will also have to be produced on islands, sandbanks and in small boats. As under ordinary circumstances smoke will hardly persist for longer than half an hour, further supplies of smoke-producer must be arranged for whenever a screen is required for more than that time."

The Author gives three examples of smoke-screened crossings :—The crossing of the Dwina, near Riga, by the Germans in October, 1917 ; a crossing by the Austrians in June, 1918, and one by the Italians in October, 1918.

Anti-tank Defence. Extracts from the *Army and Navy Journal*, of the U.S.A., giving the effects of explosives against Renault tanks.

Tank-crossings. Extracts from the *R.T.C. Journal*, for February, describing Major Martel's demonstration before the Colonial Premiers at Sandhurst.

(*July-August*, 1927.)—*An Example of an Opposed River-Crossing*, by Major Rendulic.

As the river concerned is the Piave, and as the crossing here described took place within five miles of where the British crossed four months later, it is impossible to avoid comparisons. The negotiating of the same large and difficult river is common to both cases, also that the enemy held a strong position on the opposite bank. Here the resemblance ceases. In October, 1918, the tide of victory was flowing, and our troops, full of determination, crossed the Piave against an enemy in a state of approaching demoralization. In June, as this article relates, Austrian troops fought their way over, in a carefully-planned and executed attack, against a stout resistance, which included a superiority both in aircraft and in heavy artillery. Of these two crossings of the Piave, that by the Austrians is, therefore, likely to furnish more instructive lessons than that by the British, both to Engineers and to the other arms.

Extracts from the orders of the Corps concerned are given, and from those of one of the three divisions engaged. These the Author considers " masterpieces of clear and appropriate orders, possessing permanent instructional value." The object of the enterprise was the capture of the Montello, a hill on the right bank, 600 feet high, as a necessary preliminary to the advance of the Isonzo Army, to the south, on Treviso.

The preparations were systematic and thorough. Fourteen Sapper Companies, ten Bridging-trains and 384 boats were distributed amongst the divisions as special allotments. The total number of guns per division was brought up to 200. The number of A.A. batteries was

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increased from three to eight, and a large number of machine-guns was allotted for the A.A. defence of the crossings. The necessary bridging material was brought up by train and lorry and parked under camouflage three to eight km. from the front. Careful reconnaissances were made of all approaches and of the river-bed, including the profiling of every likely crossing-place. Places of concealment for the bridging material nearer the front were selected and prepared, and, since at most 16 half-pontoons could be brought forward *per* division *per* night, the moving forward of the bridging material started 17 days before the assault. In nearly every case, man-handling was necessary for the last mile up to the place of concealment. Training in back areas of both Engineers and infantry took place. The former were put through pontooning courses on the Tagliamento and the Livenza, and all of the latter, who were to be shipped across before the bridges were built, practised embarkation and disembarkation.

On the 15th June, shelling of the enemy's batteries in the form of gas-surprise started at 3 a.m. This was followed by one hour's gas-shelling of the same targets, and then 3½-hours' bombardment of the front line and batteries. During this and from 5.30 a.m., foremost brigades to be shipped over; at 7.40 a.m., storming of edge of the Montello: bridges to commence as soon as capture complete: by midday, one bridge to be finished in each divisional sector, the crossing by pontoons to continue meanwhile: on completion of bridges, the rear brigades and artillery to cross; under protection of barrage, the attack to be continued on enemy second and third lines. Thus far the orders; what happened was as follows: The left division had all its pontoons and most of its boats destroyed by 11.30 and transhipping was stopped after 1½-battalions had been got across with 530 casualties, while the Sapper Company lost 70%; no bridge was possible, and a new place was chosen one kilometre up-stream for both transhipping and bridge; on the other hand, the storming-troops had suffered so much from m.g.-fire that they stormed the river bank at 7.15, twenty-five minutes ahead of schedule. The centre division had one bridge, over 100 metres long, across the north arm of the river by 8.30 a.m., and a second over the south arm by 12.45. The right division, like the left, could get no bridge built. Here, too, the infantry would not wait, and had stormed the river bank by 6.15. Subsequent progress from this line was: the left division had captured the Italian third line by 9.40 a.m., but could not get any further all day. The centre division (the only one having bridges) had all its infantry and two mountain-batteries over by 2.40 p.m., and got forward to a line 4½-km. from the river. The right division, partly by transhipping and partly by using the centre division's bridges, was able to get forward the same distance.

In the next few days, the situation elsewhere had altered to such an extent that orders for the withdrawal from Montello were given. These were sadly obeyed, the evacuation being faultlessly carried out on the nights of the 21st and 22nd June. The Engineers were prominent to the end, a last worthy effort being when, having seen that the enemy had reached the river bank, a party set out in two pontoons to bring away possible stragglers, and lost seven killed out of ten in the attempt.

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Co-operation of Fleet and Army in the Great War, by Colonel von Suhay. The Author deplores that public opinion, accustomed to expect the decision from the Army, and following its operations with feverish attention, attributed too little importance to the Navy and was inclined to look upon fleets as more or less necessary but inactive spectators. No conclusion could be less justified. While millions opposed each other on land and the Great War appeared as if it must end in a draw, it suddenly came to an inglorious end owing to the internal collapse of the Central Powers. This fateful event was a consequence of the blockade, which, by cutting off the Central Powers from the world's resources, starved them physically and morally. Success was thus the achievement of superior naval force : it was the fleets of the Entente Powers which decided the War. While armies struggled vainly for a decision, that decision was found by sea forces, and that even without having to fight a great battle to obtain it. The Author then proceeds, in order to stimulate an understanding of how Army and Navy can co-operate, to investigate broadly :—

(1) The *rôle* played by the Navy in the plans of campaign of the land forces.
(2) To what extent the Navy participated in those operations of the land forces in which the sea played a part.
(3) The nature of the co-operation in cases where Army and Navy worked together for a definite war purpose.

As regards (1), in Germany and in Austria, in 1914, the navies were under the respective G.H.Q.'s, but this single control was only nominal. Since it did exist, however, the C.G.S. should have given the navy, in peace, such directions as would ensure unity of action with the army in war, but the G.S. left all naval preparations for war to the navy. Excepting England, most nations agreed that the war must be decided on land. General Staffs laid their plans accordingly, and the method of using the fleet, being considered of subsidiary importance, was left to the naval authorities. Thus it happened, when war came, that armies assumed the offensive while their fleets remained on the defensive.

For example, the German Navy was not informed of the plan of campaign of the German Army to attack France by outflanking it through Belgium. Moltke, the C.G.S., attached no importance to the Navy making their plans fit in with this scheme. In 1908, however, the Admiral C.-in-C. intended, in a war with England, to use the fleet offensively. His more cautious successor, in 1914, used a relatively stronger fleet on the defensive ; and yet the German plan of campaign on land was the same in both cases. The C.G.S. had no influence on either of the naval C.-in-C.'s, regarding the fleet as a sort of strategic reserve, a protector of the coast, and a weapon to be held in hand for the eventual peace negotiations. This idea of saving the fleets had some foundation in a peculiarity of naval warfare, viz., that a great sea-fight is a life-and-death struggle, *e.g.*, Santiago, Tsuschima, Coronel and the Falkland Islands, where the fleets defeated—Spanish, Russian, British and German—were wiped out. " Who knows," the author asks, " how Skager Rack would have ended but for night breaking it

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off?" His implication is clear, that the Germans should have fought it to a finish.

In the case of other nations, he admits that there was a closer relationship between army and navy in England's war-plans, and to some extent in those of France, but such co-operation was not strategical, but a necessity arising from the geographical position of the probable theatre of war, since naval co-operation had to be arranged beforehand for the transport by sea of the British Expeditionary Force and of the French contingents from Algiers and Morocco. A study of the course of the war, however, reveals that war plans might have been entirely based upon a strategic use of fleets. This is specially true of Germany, where the weak points of the otherwise ingenious Schlieffen plan demanded a strategical *rôle* for the German High Sea Fleet, since a German naval offensive alone could have brought about the desired prevention of English sea-transport. It could not have been a matter of indifference to German G.H.Q. that Britain brought "its excellent army," 120,000 strong, to the Western Front, especially since Germany no longer possessed a numerical superiority there, owing to Italy's secession from the Triple Alliance.

After the fronts had stabilized, it was England that first recognized that a decision could no longer be hoped for on land, and transferred the gaining of a decision to the Fleet. As soon as Germany began to realize whither the blockade would lead, it also decided to use its Navy for strategical purposes, viz., to raise the blockade; but too late.

(2) describes in detail the chief incidents of the Austrian naval history of the war, from which it appears that co-operation between navy and army was very close throughout.

Under heading (3) the first place in undertakings where army and navy worked together with a definite war-purpose is awarded to the Navies of the Entente Powers, not only for their transport work mentioned in (1) above, but also for bringing 1,200,000 Americans, together with an enormous quantity of war material, 3,000 miles to France without loss of any kind. Colonel von Suhay does not like to admit that this success was due to radio-compass work directed against the German submarines, but without that aid the performance would be more wonderful still. He classes the achievement as "worthy of admiration as one of the greatest performances in the war." Two examples are then given of army and navy co-operating, apart from purely transport purposes, viz., the German seizure of the Baltic Islands and the attempt on the Dardanelles, "the greatest combined war-undertaking by army and fleet that ever took place and which cost defender and attacker each a quarter of a million men."

Railways in War. General Ratzenhofer continues his article. He shows how, before the Great War, the popular idea of the shortness of a modern war, and hence of the importance of early successes, was held by the military staff concerned with railways in Austro-Hungary, and that upon this idea their schemes were based, all things being so arranged and ordered as to assist in the mobilization of army and fleet being

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carried out as rapidly and as accurately as possible. These preparations envisaged war on four-fifths of the Austro-Hungarian frontier, *i.e.*, omitting only the frontiers of Germany and Switzerland, and included for all possible cases of war and war situations the preparations of lines of communication on the main lines of traffic, and guarding against hostile undertakings and sabotage.

When war came, all this fell far below what was required. The change from mobile to stationary warfare with its undreamt-of mass and variety of requirements, the provision of light military railways in every theatre, the restoration and running of many thousand kilometres of enemy railways in the East, South-east, South and South-west, the endeavour to compensate for numerical inferiority on whatever happened at the time to be the more important front by increase of transport-activity —all these were new factors, to which later were added difficulties arising from lack of raw material, lack of personnel, failure of other means of transport, and finally passive resistance and strikes, due to exhaustion and dwindling will to victory.

The remainder of the article, which is to be continued, deals with the description of the railway system in peace, the duties of the military railway authorities (*i.e.*, the railway branch of the General Staff) in peace, and their general provisions for war.

The Development of Artillery Material in and since the War (continued). Describes this month with eight photographs and seven drawings :—

A. Infantry guns, the French M16, the Beardmore, the new Polish infantry gun (Pocisk system) and the new American experimental gun M25 E.

B. Field guns, improvements in the French C97, the English 18-pr. Mark IV, " a very pretty gun," and Mark V carriage, new guns by Schneider, St. Chamond, Skoda and Bofors. The palm is awarded to the American experimental guns constructed according to the Directors of the Westervelt Board.

C. Medium artillery. No essential development during the war, but since then progress has been made by the Americans and by Schneider.

F.A.I.

(*To be continued.*)

HEERESTECHNIK.

(*January*, 1927.)—With this number the magazine changes its publishers to the well-known firm of E. S. Mittler and Son, Berlin, S.W.68.

Modern Internal Ballistics, by Dr. Becker. The second volume of Cranz's masterpiece on ballistics has just been published by Springer. It deals with internal Ballistics, contains 450 pages, and has been eagerly awaited for years both in Germany and abroad. This volume contains not only Cranz's own experiences, lasting over many years as

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instructor and principal of the Ballistic Laboratory at the Military Technical Academy, but also introductory articles on the thermodynamic and thermochemical principles of internal Ballistics and on explosive-constants by Professor Poppenberg, and an article on external Ballistics by Professor Eberhard, of Krupp's.

The Tars and their Products. The first instalment of this article is devoted to pit-coal tar and contains, in addition to plan and elevation of a distiller, a useful "genealogical" tree showing the principal products of the pitch and of the distillate under the usual headings Gas-liquor, Light, Medium, Heavy and Anthracene oils.

The Dispersion of Projectiles, by E. Wedemeyer. The chief causes of the dispersion of shells and bullets, whether under the head of internal or of external ballistics, are enumerated, and the Author then shows by simple examples how even a minute deviation of its centre of gravity from the longitudinal axis may be the greatest disturbing element in the flight of a projectile, and further that, even when the centre of gravity of the shell lies truly in the axis of rotation, it may happen that the centres of gravity of the forward and after portions of the projectile lie outside that axis and form a disturbing couple.

The Present Position and Prospects of Photographic Survey. This article by Lieutenant-Colonel Boelcke, who in the Great War was the head of the War Survey Service in Germany, makes its appearance in order to mark the occasion of the second Congress of the International Association for Photographic Survey, held at Charlottenburg in November, 1926.

The Association was founded, in 1907, in Vienna, as an Austrian Society; was extended, in 1909, to include Germany and has now, after a lapse of thirteen years, held its second General Meeting. On this occasion the following States were represented: Austria, Germany, Switzerland, Sweden, Norway, Greece, Italy, Poland, Russia, Czecho-Slovakia, the Ukraine and Colombia.

The art of photographic survey, although necessarily confined at its inception to mountainous country, has now, owing to the success achieved by photography from aeroplanes, received so great an extension of its sphere of utility as to be able to replace former topographic methods.

The Author mentions the apparatus installed on the tops of the survey-ship *Meteor*, which, on Atlantic voyages, photographs the waves and measures their heights accurately to one centimetre. Also Lieut. von Orell's Stereo-Autograph, which was used with great success during the war in mapping the mountainous districts of Macedonia, of which the existing maps were quite inaccurate. Also Hugershoff-Heyde's Aerokartograph, a portable instrument, invented by Professor Hugershoff and constructed by the firm of G. Heyde in Dresden, which draws accurately contoured maps from stereoscopic photographs. A photograph of this wonder-work is shown.

(*February*, 1927.)—*The Czecho-Slovakian Light Machine-Gun* /24. A machine-gun can only be judged properly by its battle performances, but this weapon is worthy of consideration owing to its having been the winner of the international competition which took place at Milovice,

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in 1924, since when it has been introduced into the Czecho-Slovakian Army.

The shape adopted is that of the ordinary infantry rifle; weight, including supporting fork, 20 lb.; gas-pressure loading; magazine, fitted above the barrel, contains 30 rounds; theoretical rate of fire, 540 to 640 rounds a minute.

The article gives every detail, with photographs and diagrams.

The Motor Vehicle in Snow. Two cases occur: the use of special vehicles and the use of special devices on ordinary vehicles. The use of special motor vehicles during the winter does not need to be considered in countries where firm snow lasts only a short time. It is then only a question of adding an equipment to ordinary motor vehicles, such that they can change easily from one system to the other.

The answer to the general problem of how to keep motor vehicles from digging themselves into the snow is to use the lightest possible vehicles, to increase the number of axles, to use large low-pressure tyres, and to put on anti-skidding chains, not as rings but as an endless screw. These chains must be made fast so that the wheel cannot turn inside them.

Photographs are shown of:—

(i) A motor-cycle with runners which can be lowered and raised as required.
(ii) The Austrian Aquillon system for lorries, viz., front wheels on runners, hind wheels replaced by runners, between which is a chain-driven track, which the driver can raise or lower.
(iii) The Swedish Nyberg system, viz., front wheels on runners, hind wheels replaced by tracks.

The latter system has been adopted by the Swiss postal authorities for their post-omnibuses, and with certain improvements, including rubber tracks, is used in the Upper Engadine.

The Tars and their Products. Deals with the successive fractions in the destructive distillation of coal, viz., light oil, medium oil, heavy oil, anthracene oil and pitch; how each is obtained, of what it consists, its uses, and the details of all washing-processes.

The Creation of a British World Network of Air Routes. It is considered that the projected air routes London–Capetown, London–Singapore–Australia, London–Kenya, with extensions to important centres in S. Africa, will not only form a basis for trade and travel purposes, but will be an important foundation for the development of Imperial Defence. These routes are still only to be regarded as a small beginning of what the British Government intends to carry out.

German War Gas. The *Revue d'Artillerie* (*December*, 1926) is quoted as authority for two statements about German progress in war gas, which are startling enough to be unconvincing without authentification. Some pains have been taken to track down this Report, and the trail leads back from Paris to Rome (*Rivista di Artigleria e Genio*), from Rome to Vienna (*Militärwissenschaftliche Mitteilungen*), from Vienna to the United States (*Chemical Warfare*), and thence, completing the vicious circle, back to France again (*La Croix*). It would thus have been

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simpler for the *Revue d'Artillerie* to draw on *La Croix* in the first place, but in that case the report would not have been able to attain its full snowball-growth. Science and propaganda make an ill-assorted pair.

(*March*, 1927.)—*Artillery Draught.* Consists mainly of extracts from an article in *The Field Artillery Journal*, by Captain Winton, who, after experience of a horsed battery in war and of a mechanized battery in peace, sums up the pros and cons from a battery-commander's point of view. The German reviewer agrees in general with the soundness of Captain Winton's deduction in favour of the dragon.

The Tars and their Products. This third (and last) instalment deals with brown-coal tar and its products, with distillation and washing processes.

The chief product, although only amounting to 10 to 12 per cent. of the whole, is paraffin, and this is almost entirely used for candles; next comes, 5 to 6 per cent. only, brown-coal petrol, which is chiefly used for cleaning the paraffin; then Solar oil, cleaning oil, yellow oil and red oil, used for Diesel engines; gas oil, formerly used for making oil gas and latterly for making carburetted water gas; asphalt and creosote.

Construction and Effect of Aerial Bombs, by Major Justrow. The Author shows how the war caught aviation quite unprepared for aerial bombing, and that, although, during the war, there was a development in the shape of the bomb from sphere to cylinder and torpedo, the best shape was never decided, let alone such questions as the best distribution of the weight, the number, size, and best position of the steering-vanes and their correct curvature for ensuring regular rotation and thus stability of flight. As regards types of bomb other than mere explosive, the gas bomb received no attention in the war, being useless against troops in the small concentrations which alone were possible, while no nation was willing to incur the odium of being the first to use it against towns. With incendiary bombs a certain amount of success was achieved against French and English towns, but Major Justrow considers them inferior both in destructive and in demoralizing effect to the ordinary explosive bomb. He looks, however, to a development of both incendiary bomb and gas bomb as certain.

(*To be continued.*)

Present-Day War Technics. The review of a book by the editor of the magazine, Lieutenant-General Schwarte, which has been written to inform Germans of the technical progress of the armies of other countries, and thus to bridge over the time until Germany has the same right as other nations to develop its war technics. The book's object will have been achieved if at some future date Germany may be found equipped and well prepared—at any rate in mind!

Russian Views of the Structural Measures to be taken for the Protection of Town Dwellers from Air Attack. Modern war being a matter of nations, and not of armies, the great development of aviation and of air fleets since 1918, and the zeal expended in finding out and perfecting war gases, make it certain that these new weapons will be used in the fullest measure against national sources of strength.

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In Russia, at any rate—to judge by reported utterances in Russian military literature—there are no illusions in this respect.

The following are characteristic of the point of view of military (and civil) circles in the Soviet Union :—

(1) No Hague Tribunal has been able to prevent wars in the past ; no Locarno will in future be able to stop their breaking out, so long as the political economic and social causes of wars persist.
(2) Future war will be a war of armed peoples to the death, in which all means are " good " and " permissible." The possibility of distinguishing between means which are permitted and means which are forbidden is a fiction and self-deception.
(3) Reliance on the effect of international treaties (which at the first shot are changed into " scraps of paper ") or international agreements, which forbid " barbaric methods of conducting war," is vain.
(4) The most extended use of all methods and means of destruction from the air—by bombs and poison gas—is to be awaited with certainty.
(5) Owing to aviation, the ideas of " front " and " line of communication " have changed their significance.
(6) Even the existence of a powerful air fleet and strong anti-aircraft artillery cannot guarantee the safety of large towns, administrative, industrial and trade centres, in the interior of the country.
7) Hence, every citizen—even living hundreds of kilometres from the frontier—may find himself exposed a few minutes after the declaration of war to hostile explosive or gas air-bombs.

The result of the warnings issued by the Soviet Union was the formation of two large organizations, the *Dobroljot*, or league for the voluntary creation of a strong air fleet, and the *Dobrochim*, or society for the promotion of the chemical industry and preparation of the chemical defence of the country. These two organizations, of which the latter had already in the year of its foundation 12,000 groups, comprising 1½-million members, became united in May, 1925, under the name of the *Aviachim*, having the same purposes as the parent societies and also the instruction of the population on the importance and properties of the two methods of warfare. The *Aviachim* works in the closest touch with the People's Commissaries for National Defence, Internal Affairs, Economics, Communications and Health.

The following, though written by " A Civil Engineer," is believed to represent Soviet Government ideas :—

" The development of aviation, which has made national frontiers illusory, at the same time does away with the hitherto sharply-drawn boundary between military and civil building. When every civil building is at any time in war threatened with destruction by bombs, civilian architects are forced to concern themselves with the effects of these changes and to build accordingly. As in the Middle Ages nearly every town was a fortress, and many buildings were of the nature of castles, and as in the time of the Renaissance every architect was to a certain extent a designer of fortresses, so nowadays the ever-

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present danger of war demands that the civil architect should adapt himself to the requirements of war in solving the problem of the protection of the people's dwelling-places. And indeed the study and knowledge of the modern methods of conducting war will not only necessitate another standpoint for the designing of single houses, but probably for the planning of whole towns."

F.A.I.

(*To be continued.*)

CORRESPONDENCE.

THE EDITOR, *The R.E. Journal.*

SIR,

The Journals of our great technical Institutions teem with "Discussions," "Communications" and "Correspondences." In fact, these are often as illuminating as the original papers to which they are appended. Half-an-hour's study of the *Proceedings of the Institution of Civil Engineers* will convince anyone of the value of such appendages.

But it is rare for an article in our *Journal* to evoke any form of reply. One wonders whether it is that we are too modest. Or is it that we are too uninterested? Or are we too busy? Surely not. Perhaps it is not realized how discussion can enliven the dullest subject, how the liveliest can be enriched by keen comment. I cannot believe that the articles are tedious beyond hope of enlivening, nor that they are so perfect that to add one jot or tittle would be to gild refined gold.

Having said this much, may I be exempted, this time at least, from putting into practice what I have preached, and merely remain, Sir,

Yours, etc.,

C. A. DE LINDE.

Ecole du Génie, Versailles,
21*st January*, 1928.

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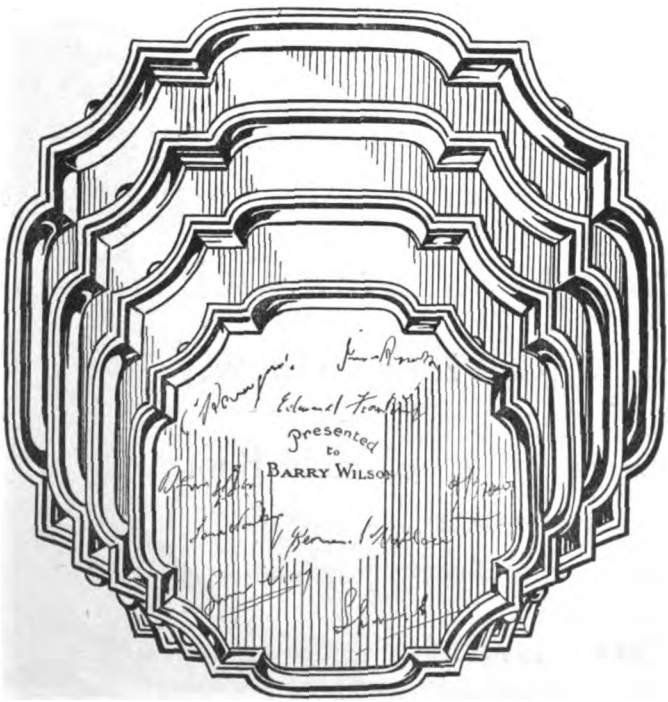

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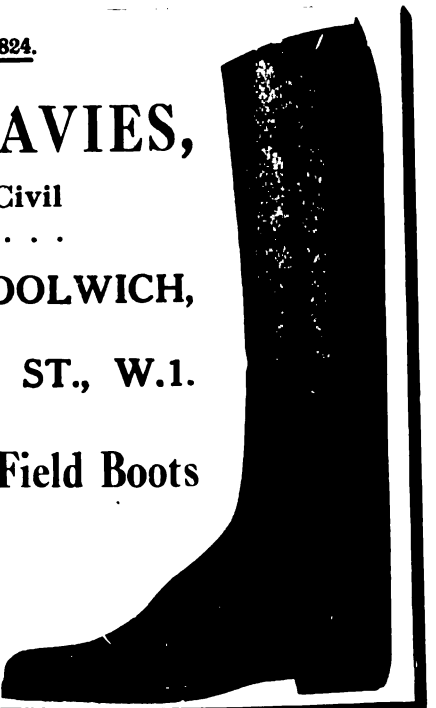

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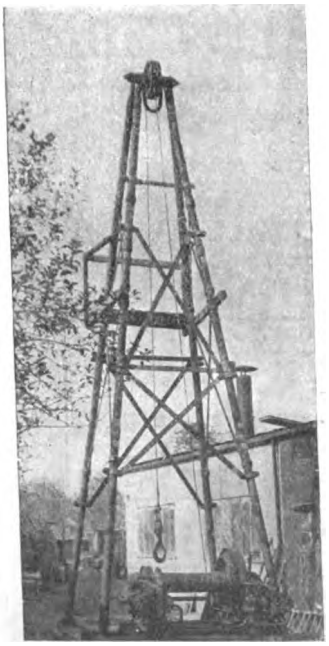

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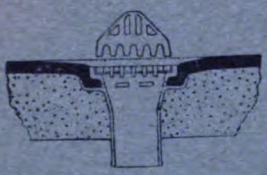

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Major R. *P.* Pakenham-Walsh, M.C. 1926
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THE DIRECTION OF NATIONAL EFFORT IN WAR.

A Lecture delivered at the S.M.E., Chatham, on February 23rd, 1928, by MAJOR G. N. MACREADY, D.S.O., O.B.E., M.C., R.E.

ALTHOUGH war has been the principal international pastime for a very long time, a national war—that is, a war involving the whole of a nation's effort—is a comparative novelty.

One hears of people living in the Highlands, or in remote country districts of England, who never heard of the Napoleonic wars until they had nearly ended, but I doubt whether any inhabitant of these Isles did not hear of and feel the effect of the Great War before a very few months had passed. At the front, of course, one often heard the remark that the people at home did not realize we were at war until the gin and bitters ran short, but such remarks were not meant to be taken seriously.

What is meant by the production and direction of National Effort.—As a result of our experiences in 1914–1918, our conception of war has had to be largely modified. As Sir William Robertson said recently at the Royal United Service Institution :—

> " War is not nearly so much a matter for soldiers and sailors alone, as soldiers and sailors sometimes think. On the contrary, it embraces all the activities of the nation."

It must also be borne in mind that, when a nation is fighting for its life, it is almost impossible to draw any hard-and-fast line between the imperious, and almost insatiable, requirements of the fighting services, and the essential needs of the non-fighting departments and the civil population.

The life and the enthusiasm of the whole people must be maintained ; the economic fabric of the nation must not be imperilled ; our relations with neutrals must be safeguarded.

A general view and a just apportionment are essential. It is, therefore, not merely a case of arranging to provide the fighting services with vast quantities of men and stores, most of which are of special design, and many of which are not produced commercially in time of peace—though that in itself is a gigantic undertaking. It is a case of foreseeing and providing for the whole vast total of the nation's requirements.

If we extend this to the Empire, we find that the problem

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confronting us is nothing more nor less than the preparation of plans for the mobilization of the entire resources and industries of the Empire, and their employment in a unified and pre-determined manner.

Peace-time organization.—Now, whatever type of machinery may be evolved for directing national effort in war, the starting point of transition must be our peace-time administrative organization. Let us take a glance at this. We have a Cabinet, consisting of twenty-one ministers, including the Prime Minister. Each of the fighting services is controlled by its own minister, responsible only to the Cabinet. The Navy, Army, and Air Force recruit their own personnel, have their own supply departments, their own programmes, and their own contractors. Owing to their comparatively small requirements in peace-time, their recruiting and supply interests rarely clash, either with each other or with the civil community.

Again, while the Ministries of Health and Labour, and the Board of Trade regulate the life of the civil community to some extent, and the Chancellor of the Exchequer makes it his business to extract from us as large a proportion as possible of our hard-earned pay, the ordinary civilian can do pretty well what he likes in peace-time. We can all drink as much as we like, as long as the after-effects do not attract the attention of the police; we can eat as much meat, butter, and sugar as we like, without wondering whether there is likely to be a shortage of these commodities at any time.

In short, for all practical purposes, each service and each department functions in peace-time as a separate entity. Whether this should or should not be is beside the point. We must take the situation as it exists as our starting point for war preparation.

The first question that obviously arises, when one looks at the situation I have described, is: "How on earth can adequate plans for a national war be evolved, when in peace-time you have such a multiplicity of departments, working entirely separately from one another?"

Neither the principles, the policy, nor plans for defence can be dealt with by one service, or even by the three services together, for everywhere they are found to involve co-operation by other Departments or Governments, such as the Treasury or Foreign Office, by India, the Dominions, or Colonies.

Similarly, to give effect to the war plans of the services, ancillary preparation is required by many departments, and has to be concerted inter-departmentally in many matters, such as censorship, blockade, communications of all kinds, transport, supplies, man-power, and so forth.

In short, before we start thinking of how the national effort is to be directed in war, there must be some inter-departmental

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organization to plan in peace-time how the national effort is to be produced.

Such an organization exists in the Committee of Imperial Defence.

The Committee of Imperial Defence.—In the time available, I can do no more than give you an outline of the composition of the Committee of Imperial Defence and how it works.

The Committee of Imperial Defence is a purely advisory and consultative body. It cannot decide, it only recommends. This does not, however, necessarily mean that all recommendations of the Committee go to the Cabinet. Large questions of policy are always referred to the Cabinet for approval. Recommendations on lesser questions, which, if they were purely departmental, would fall within the authority of a Minister, are dealt with under ministerial authority.

Composition of the Committee of Imperial Defence.—As regards its composition, the Committee consists technically of the Prime Minister and such persons as he may summon to consult with him. This elastic arrangement enables anyone who can contribute useful advice, or information, to be summoned to the Committee or its Sub-Committees. As a rule, however, among the Members who regularly attend meetings are the Secretary of State for Foreign Affairs, the Chancellor of the Exchequer, the Ministers of the three fighting departments, and the three Chiefs of Staffs.

The Chairman.—The Esher Committee, on whose recommendations Lord Balfour based the organization of the Committee of Imperial Defence in 1904, considered it a vital necessity to have as its invariable President the Prime Minister of the day, and although, for a few years immediately after the War, pressure of business prevented the Prime Minister from attending regularly, and necessitated the appointment of a Deputy Chairman, the general custom has always been for the Prime Minister to attend meetings in person. There are, obviously, considerable advantages in this. Firstly, the Prime Minister, as Chairman of the Cabinet, is better informed on defence matters if he is also Chairman of the Committee of Imperial Defence. Also, as I shall explain later, the higher control in time of war must inevitably be exercised by the Prime Minister. It is, therefore, advantageous if he has studied defence problems in some detail, and got to know the Service authorities beforehand, by presiding at the Committee and some of its more important Sub-Committees.

Sub-Committee organization.—The main work of the Committee of Imperial Defence is carried out by Sub-Committees, a very large number of which exists. Some of these Sub-Committees are permanent, and are constantly engaged in reviewing war requirements,

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and keeping war preparations up to date. Others are merely *ad hoc* Committees set up to consider particular questions which arise from time to time. You will get some idea of the activities of the Committee of Imperial Defence and its Sub-Committees, when I tell you that, in 1926, 218 meetings were held, attended by about 430 people, including 19 out of the 20 Members of the Cabinet, 142 Service Officers, 157 Civil Servants, 6 representatives of the Overseas Empire, and 48 experts outside Government service.

I have no time, in this lecture, to describe the work of all the important Sub-Committees. All that I can tell you is that every possible aspect of war is studied, and, where necessary, schemes are prepared. For instance, the Supply and Man-power questions, trading and blockade, air raid precautions, censorship, imperial communications, oil fuel, and war emergency legislation, are all catered for. It would, however, be as well to tell you something of the three Committees perhaps most directly concerned with the production and direction of national effort. These are the Chiefs-of-Staff Sub-Committee, the Man-Power Committee, and the Principal Supply Officers' Committee.

Chiefs-of-Staff Sub-Committee.—The Chiefs-of-Staff Sub-Committee is under the direct control of the Prime Minister, who himself presides when political guidance is required; but when technical matters are discussed the senior Chief-of-Staff is Chairman. The functions of this Committee were set forth in the Report of Lord Salisbury's Committee in the following words:—

> "In addition to the functions of the Chiefs-of-Staff as advisers on questions of sea, land, or air policy respectively to their Board or Council, each of the three Chiefs-of-Staff will have an individual and collective responsibility for advising on defence policy as a whole, the three constituting, as it were, a Super-Chief of a War Staff in commission. In carrying out this function they will meet together for the discussion of questions which affect their joint responsibilities."

One advantage of the setting up of this Sub-Committee is that the Committee of Imperial Defence now receives collective advice, instead of separate and sometimes contradictory advice, from three separate sources. There are, of course, occasional differences of opinion when a question is first discussed by the Chiefs-of-Staff, but discussion almost invariably leads to a reconciliation of the various points of view.

Man-Power Committee—It is clear that, in preparing for the mobilization of the whole resources of the nation, nothing is more important than the organization of man-power. This is the task of the Man-Power Committee, which works through six Sub-Committees.

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The present Chairman is the President of the Board of Trade, who was the right-hand man of the Director of National Service in the later stages of the War, with representatives of the Service Departments and other Departments concerned, such as the Ministry of Health and the Registrar-General. Great progress has been made in this matter, and should it again be necessary to set up a Ministry of National Service, this Committee should be in a position to provide, not only a nucleus staff, but complete plans and statistics which will enable general mobilization of the nation's man-power to be undertaken with the least possible delay.

Principal Supply Officers' Committee.—The tendency towards mechanization of modern warfare renders the production of war material one of the most important tasks in the organization of our defensive preparations. The co-ordination of this work is the task of the Principal Supply Officers' Committee. This Committee works through seven Supply Sub-Committees, each of which is responsible for investigating a particular portion of the vast field of war requirements. There is, in addition, a Contracts Co-ordinating Committee and a Supply Board, whose object is to ensure that the seven Supply Committees work on a uniform policy and in close co-operation with each other. The Board of Trade is responsible for tabulating and co-ordinating the statistics furnished by the various Supply Committees, and for exploring the field of availability for materials. If and when a Ministry of Supply became necessary, the Board of Trade officials engaged on this work would provide a trained nucleus. The necessity for a supply organization of this kind is clearly shown by the history of the late War. Before the War, each of the fighting departments—and, of course, in those days there were only two—was responsible for its own supply arrangements. Each had its own Supply Department, its own Factories, its own Contractors, and its own Programmes. There was no clashing of interests, and therefore no need for co-operation. In these circumstances, and the idea of a war of national effort never having been considered, supplies scarcely came within the orbit of the Committee of Imperial Defence. You all know that, during the War, this machinery soon proved inadequate to cope with the war problem of supplying an Empire in arms, to say nothing of assistance to our Allies. No system existed for the co-ordination of the various supply agencies; there were no arrangements for organizing the expansion of manufacture of the nation as a whole, which was left at first mainly to armament firms. There was no machinery for determining priority as between competing demands for strictly limited supplies. As a result, it was impossible to obtain a general view of national requirements, or to draw up comprehensive supply programmes. Manufacturing capacity was inadequately exploited, and the lion's share of our limited production went not necessarily to the most needy, but to the most importunate.

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As early as May, 1915, a new departure became necessary, and all indications pointed to the advisability of entrusting the task of mobilizing the industrial resources of the country as a whole to a new and separate department.

The Ministry of Munitions was set up; it inevitably developed into the most enormous concern, and it successfully delivered the goods. But there are three points worthy of attention: firstly, this Ministry was only concerned with the engineering and allied industries, except ship-building; secondly, naval war material was never included within its orbit; and, thirdly, since all arrangements had to be made in a great hurry, the cost of munitions was probably infinitely greater than it would have been, had detailed preparations been made beforehand. *Now*, in peace-time, the Service Departments do their own shopping as before, but it is expected that, in the event of war, supply requirements will be co-ordinated by the Principal Supply Officers' Committee, and competition between the Services should be eliminated.

I hope that I have now convinced you that, in the first place, any efficient system for direction of our national effort in war must be based on the peace-time administrative organization, and, secondly, that we now possess adequate arrangements for preparing to produce our national effort. You will probably say, however, that what I have said tends rather to complicate the direction of our effort in war than to simplify it. We are starting in peace-time with a Cabinet consisting of the Prime Minister and twenty other ministers, and I have mentioned the possibility of at least two additional ministers, for Supply and Man-Power. Surely this makes the machine more unwieldy than ever! Would it not be possible to centralize the control of Departments that must work closely together? We have a Chiefs-of-Staff Committee for tendering joint advice. Why not go a step further, and have a Ministry of Defence? This is a question I should like to consider in some detail.

Ministry of Defence.—A Minister and a Ministry of Defence certainly have an attractive sound. The Services exist for a common purpose—war—and at first sight it seems logical that all the forces devoted to this object should be administered by one Minister and one Department with a view to complete co-ordination, avoidance of duplication and overlapping, and reduction in expenditure. With these objects everyone must be in accord, and it is a question of practicability and method. It is, therefore, no surprise that a Ministry of Defence became a kind of catch-word. It was advocated by the cheaper newspapers; even some of the more important organs of the Press have at one time or another toyed with the idea. A number of Members of Parliament, including officers of wide experience, have supported the plan. Why is it then that a scheme so attractive at first sight, and so warmly

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supported, has not been adopted? A considerable stimulus was given to this idea by a notable speech made in the House of Commons by Mr. Churchill, in March, 1922. The key-note of this speech is contained in the following extract :—

> "The co-ordination of the three Services can only effectively be attained through a process of unification, of realization by all members of those Services that their business is to defend the country as a whole. Whether they serve in the air, or at sea, or on land, ought not to be a cause of differentiation any more than exists between the Cavalry, Artillery and Infantry, who are all gathered under the War Office. No solution of a harmonious or symmetrical character will be achieved in the co-ordination of the Services except through the agency of a Ministry of Defence, but it is not possible to create such a body at the present time, nor will it be possible for a considerable time. In the interim, the only steps which are open to us are to create machinery for pooling the administrative functions of the three arms, and to create a common staff brain, from whose exertions in the future the responsible advice given to the Cabinet of the day in regard to matters of defence must and can only effectively originate."

You will notice that Mr. Churchill indicated two preliminary steps. First, to create machinery for pooling the administrative functions of the three arms, and, secondly, to create a common staff brain. Effect has been given to the latter suggestion by the recent establishment of the Imperial Defence College. As regards the former, a Committee had already been set up in February, 1922, "To make definite proposals for safeguarding as far as possible the common Services of the Navy, Army, and Air Force, such as intelligence, supplies, transport, education, medical, chaplain, and any other overlapping departments, in order to reduce the cost of the present triplication."

This Committee worked for nearly a year and its Report, although completed in 1923, was only published in 1926. The first recommendation of this Report is as follows :—

> "We are of opinion that, in existing circumstances, the complete or partial amalgamation of the common services of the three fighting departments is not advisable, and we do not believe that any substantial economies would thereby be effected."

Instead, the Committee recommended the establishment of a whole series of co-ordinating Joint Committees, on such subjects as the medical, educational, intelligence, supply, transport, and works services. With the exception of the intelligence services, which

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were found already to work in close contact, these Committees were all set up. Their reports are reviewed annually by the Committee of Imperial Defence. They have achieved very considerable results in the direction of economy by arrangements for the purchase and inspection of clothing, stores, mechanical transport, etc., by one department on behalf of another ; by the adoption of trade standards or patterns, and common specifications, by standardization, exchange of information in technical and other matters, making the hospitals of one service available to the other two, thus enabling certain hospitals to be closed, by the construction and maintenance of buildings by the department which can undertake it most economically, etc.

The Salisbury Committee.—Meanwhile, the agitation in favour of a Ministry of Defence had not abated, and in March 1923, a very strong Sub-Committee of the Committee of Imperial Defence was set up, with Lord Salisbury as Chairman, to enquire into the co-operation and correlation between the Navy, Army, and Air Force, including the question of establishing some co-ordinating authority, whether by a Ministry of Defence or otherwise. This Committee, after obtaining the views of the principal advocates of a Ministry of Defence, as well as of a number of persons of special experience, considered the criticisms to be overwhelming as against all proposals for setting up a Ministry of Defence or any Minister of Defence with authority overriding that of the Ministers at the head of the Service Departments or a combined Staff.

This account of the historical side of the question is not exhaustive, but is, perhaps, sufficient to show that, if a Ministry of Defence has not been adopted, it is not due to lack of examination. As a matter of fact, between 1921 and 1925, enquiries into our defensive system, beginning with the Geddes enquiry and ending with the Colwyn enquiry, occupied cumulatively no less than 47 months out of 53, with the ultimate result that the plan of a Ministry of Defence was definitely rejected.

What is meant by the term "Ministry of Defence?"—A point which came out strongly in the Salisbury enquiry, and which is noticeable in every Parliamentary debate on this question, is that each exponent of a Ministry of Defence has a different conception of what it should be. One plan involves the suppression of the existing Service Ministers and fusion of all the Service Departments under a single Minister. A variation of this is a plan for the maintenance of the present Departments, and their administration by a single Minister of Defence with the assistance of Parliamentary under-secretaries to take some of the work off his hands. A third scheme is that of a single Minister super-imposed upon the existing Service Ministers and their Departments. Proposals have also been

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made for a joint staff and the amalgamation of administrative Services, though how this would be fitted into the organization has not been made clear. Finally, there have been proposals for the re-absorption of the Air Force into the older Services, but I shall not touch on that question, since successive Governments of all parties have taken definite decisions on the subject. Altogether, there seems to have been a certain amount of loose and woolly thinking about details, though the root idea of economy and co-ordination is one with which we can all agree.

Three Ministers essential in war.—All proposals involving the suppression of the existing Service Ministers and Departments appear to break down in the light of war experience. The problems liable to arise in a great war in connection with each Service are so vast and so novel that they require the whole attention of even the most gifted and industrious Ministers. Consider, for example, what was involved in the raising of Kitchener's armies, the officering, recruiting, clothing, armament, supply, transport of so huge a force. Imagine what is involved in administration, to say nothing of the Parliamentary side and the education of public opinion. Much can be done by previous organization, and in this respect we shall be better off than we were last time. Much can also be done by decentralization to subordinates. But even so, an immense number of unforeseen and unforeseeable difficulties and departmental controversies will arise at every turn, which the head of the department alone can settle. Many of these problems may affect Government policy, and have to go to the Cabinet, where the Minister must have every point at issue at his fingers ends.

Take another instance, the anti-submarine campaign, with its ramifications in shipping, shipping control, diversion of traffic to unaccustomed ports, restriction on imports, and a thousand detailed questions, on which the First Lord of the Admiralty had to be informed. Or, again, take the expansion of the Air Force in war, which is at least as important as that of the older Services, with its immense potentialities, raising at every turn the most complicated problems. It seems almost inconceivable that a single Minister of Defence could in a great war handle the problems of the sea, the land, and the air simultaneously. In fact, in the Great War, the task was soon too great even for the Service Ministers and their Departments. Other great Ministries had to be thrown off, a Ministry of Munitions, Ministry of National Service, Ministries of Shipping, Blockade, Information, and eventually an Air Ministry. This experience was shared by the other belligerents, and will, to a certain extent, be repeated in a great war in the future. For all we know, we may require new Ministries for, say, Gas Warfare or Air Raids. To expand, in addition, from a single Ministry of Defence into an Admiralty, War Office, and Air

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Ministry, at a time when all branches of the fighting forces are actively engaged, would be worse than "swopping horses whilst crossing the stream"; it would be like giving birth to triplets while crossing a roaring torrent in full flood.

What is the right system?:—If then a Ministry of Defence is not practicable, what should our system be? The experience of the Great War gives us several to choose from. The German system seems to have been centred upon the Kaiser himself. It provided for the paramountcy of the military authorities without giving them complete control over all the resources of the Empire. While it no doubt produced a very high standard of military efficiency, it was distinctly weak on the civil side. The adoption of the unrestricted submarine campaign, for instance, led to the creation of a host of enemies, including the United States, and this resulted finally in the downfall of Germany. The support of the public opinion of the world was lost by this and other examples of frightfulness. Again, the civil authorities in Germany were so overshadowed by the military that they had not the prestige to maintain the national spirit. General Ludendorff writes in his war memories: "Our War Chancellors did nothing to repair the damage or enlighten the people. They had no creative ideas and did nothing to hold the people together and lead them, unlike the great Dictators, Clemenceau, Lloyd George, and Wilson."

But if, under the German system, the civilians did not enlighten the people, it was certainly beyond the capacity of the Generals to do so. In the very next sentence, Ludendorff says: "The attempts of General Headquarters to help the homeland by patriotic instruction and disseminating propaganda intended for foreign consumption within our own borders were mere crumbs to the hungry. The soul of the German people was without direction or leadership, a prey to every pernicious impression that came its way." In the following passages, also from Ludendorff's book, the German system of military predominance, which stopped short of real control, stands condemned. "Like Clemenceau and Lloyd George, I had wanted to call on the whole nation, but I was not a Dictator, as men were only too glad to repeat, false though it was. Lloyd George and Clemenceau had control of *their* Parliaments. At the same time, they stood at the heads of the entire administrative and executive authorities. I, on the other hand, had no constitutional power to influence the German Government, nor to enforce my views as to the steps necessary for the conduct of the War, and I was frequently confronted with the lack of understanding and energy of the Departments concerned."

I doubt whether a stronger indictment of the German system, or a more reassuring endorsement of the British and French systems could be found elsewhere than in this book of Ludendorff's, unless

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in the even more severe stricture of Admiral Von Tirpitz, which there is no time now to quote.

The British system.—For the first three months of the War its general conduct was in the hands of the peace-time Cabinet. This system did not work well. The Cabinet was so large, its members so busy with their own departmental problems, that it could not be summoned sufficiently often or sufficiently rapidly to deal with the great mass of business involved in the higher control of war. Consequently, at the end of November, 1914, Mr. Asquith constituted the War Council. On the change of Government in May, 1915, the War Council was renamed the Dardanelles Committee. Originally created to deal with the Dardanelles, this body very soon became in fact a War Committee, and, in the autumn of 1915, it was rechristened accordingly. The War Council and War Committee were an application to war conditions of the Committee of Imperial Defence, the main difference being that, instead of being advisory, the War Council and War Committee had powers of decision, except in matters of the highest policy, which the Prime Minister reserved for approval by the Cabinet. On December 9th, 1916, Mr. Lloyd George formed his War Cabinet, which combined the powers of the Members of the Cabinet with the machinery of the Committee of Imperial Defence tuned up to war conditions.

The French system.—The French experience was somewhat similar to our own. At the outset, the general conduct of the War was in the hands of the ordinary peace-time Cabinet. Later, there was formed a War Committee, whose functions seem to have resembled our own. On December 12th, 1916, three days after the formation of our own War Cabinet, the French Government was reorganized, and M. Briand established a War Cabinet of five members. When M. Painlevé became Prime Minister, he remodelled his War Cabinet organization closely on our own. Later, when M. Clemenceau came into office, he adapted M. Painlevé's organization to his own particular views.

For the last year of the War, the higher control in Great Britain and France was exercised in the main by Mr. Lloyd George and M. Clemenceau, both men of tremendous character, both exercising immense influence over their colleagues, but both working with a Cabinet, and subject to their respective Parliaments.

The Prime Minister must take charge in war.—One feature of this arrangement, to which I would draw special attention, is that in Great Britain, France and Italy, every organization to which the direction of national effort was committed, was presided over by the Prime Minister in person. In a country with a Parliamentary system no other course appears feasible. The moment a big war breaks out, its prosecution becomes the main feature of Government

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policy. The Prime Minister must be ready at any moment to expound that policy in Parliament. Moreover, under conditions of modern warfare, that policy is not merely a matter of naval, military, and air operations. . Every resource possessed by the nation has to be organized behind the services. Every Cabinet Minister, every Department of State is concerned. In these circumstances, who can direct the policy, who can expound it as a whole, and who can insist on the decisions of the higher control being carried out, except the Prime Minister?

If, then, I am asked who is to exercise the general direction of the national effort in war, I would answer that, in a country governed as we are, only one man is possible, the Prime Minister of the day. No one else is in a sufficiently central position. No one else can exercise the required authority. The latter is probably far the most important point.

Organization of higher control.—The next point is, what form of body is to assist the Prime Minister to exercise this control? The type of body to be adopted must depend on circumstances, such as the personality of the Prime Minister and the magnitude and nature of the war.

For a small war, the present system.—For a very small war, the ordinary Cabinet, with the assistance of the Committee of Imperial Defence and the Chiefs-of-Staff Sub-Committee, would appear to be quite sufficient.

For a medium war, a War Committee.—For a medium-sized war, of the type of the Crimean War or South African War, a War Committee is required which can take prompt decisions on all matters where time is of vital importance, and on questions of a secondary order, although in such a war the larger policy would always require the approval of the Cabinet.

For a great war, a War Cabinet.—For a war of the first magnitude, like the last, which requires the Cabinet to be in continuous session to settle a mass of questions arising from day to day, as well as to formulate and direct the policy as a whole, the experience of the War went to show, I think, that the War Cabinet is the most satisfactory system. The essence of that system was a small Cabinet under the Prime Minister's presidency, with Members free from ministerial duties, in whom resided full powers of decision. The Ministers at the head of Departments, such as the War Office, Admiralty, Ministry of Munitions, etc., attended when questions affecting them were under consideration, but otherwise they were free to give their whole time to their Parliamentary and administrative duties. The Chiefs-of-Staff attended every meeting of the War Cabinet. It is a system that would only be tolerated in the gravest national emergency. The Prime Minister of the day must

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be the judge of the moment at which the method must be changed, and it is quite possible that the War Cabinet system will again only be reached after the other systems have been tried and found inadequate.

There is much to be said for this elastic system, which leaves the precise form of the higher direction, which, I suggest, owing to our constitution and form of Government can only be one of the three I have mentioned, to be decided when the emergency arises.

Higher control of Empire Forces.—I have not dealt with the question of the direction of the Empire's effort. This raises constitutional issues of rather a difficult character, which are not ripe for solution. In the War, we solved the problem with a good deal of success by the emergency expedient of an Imperial War Cabinet. Whether that expedient would again prove acceptable to the Dominions, or whether some other system would have to be evolved, is at present rather a matter for speculation. One thing, however, seems clear, and that is that, when the ever-growing forces of the Dominions again fight side by side with our own, the Dominion Governments will have to be accorded a full share in the formulation of the war policy, and in the general organization of the Empire's war effort.

Perhaps, after this rather long and involved dissertation, it would be as well to summarize my conclusions, which are as follows :—

In order to arrive at an efficient system of controlling the direction of national effort in war, in the first place, dislocation of the normal peace-time system must be reduced to a minimum. Secondly, there must be in peace-time an advisory organization which can explore the whole field of war-time requirements, and draw up plans adaptable to every likely contingency. Such an organization exists in the Committee of Imperial Defence. Thirdly, a Ministry of Defence, either in peace-time or in war-time, does not appear to help towards war efficiency. Fourthly, the ultimate responsibility for controlling the national effort must pivot on the Prime Minister. And, lastly, to assist the Prime Minister to exercise the necessary control, there should be either the usual peace-time Cabinet and Committee of Imperial Defence, a War Committee, or a War Cabinet, according to the needs of the situation, but that it would be a mistake to lay down rigidly that any one system should apply to every eventuality.

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SCIENTIFIC SOLDIERSHIP.

By COLONEL J. F. C. FULLER.

THE simplest definition of "science" is "knowledge," but, as knowledge so frequently signifies haphazard inference and unanalysed fact, a better definition is co-ordinated or systematized knowledge. There is nothing mysterious about this word, and it is not necessarily connected, as the common mind imagines, with grey beards and abstruse problems. For example, every gardener who aims at producing artistic effect must know something of the science of gardening. He must understand not only the soil, climate, and the seasons of the year, but when and when not to plant certain seeds, for they do not all germinate, or flower, at the same times. Without this science, this knowledge of the principles of gardening, his art will be of a very low order. Similarly with the soldier, his art of war will be primitive unless it is based on science, that is, on a true knowledge of war, in place of haphazard knowledge.

How does the man of science arrive at true knowledge? By observation, reflection, and experiment. Whatever his subject may be, he is always confronted by a variety of changes. Nothing which can be studied is absolutely simple, otherwise to the mind it would become a blank zero. It is complex and possesses variety. For instance, even so exact a science as mathematics is continually evolving and conquering new spaces and exploring new or little-known dimensions. Once, Euclid was the high prophet of geometry, now he is but one of a number of geometrical masters. In war, complexity is complicated in the extreme, and the study of war is rather like unravelling a mass of entangled spider's web. The task is so difficult that many soldiers affirm, not only that there is no science of war, but that there can be no science. Such a statement is manifestly absurd, since complexity is not the negation of science; in fact, the more complex a subject is, the more necessary is it to examine it scientifically; to discover one of the two ends of the web, and by degrees unravel it.

The science of war is not to be discovered on the battle-field, for there it can only be tested out as an art. The gardener does not discover the science of gardening in the garden, for there also is his science tested out as an art. He attains his knowledge primarily by study, or by tapping the knowledge of other gardeners who have arrived at it through a long process of trial and error. So also with

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the soldier; he has the whole history of war to observe and examine. It contains an enormous number of facts—true, half-true and false, and unless the soldier has sorted out the facts of history and discovered their value, his art on the battle-field will be chaotic.

The scientist, having discovered the nature of facts, next compares them. From comparison he discovers differences; these may at first perplex him, but if they do he builds upon them a theory, and then starts to test his theory out. If, after a large number of tests, he can find no exception to his theory, he deduces a law, or governing principle. Thus, if, after throwing a great number of articles into the air, all fall to earth, this falling constitutes a general principle which governs all things material. To-day, this general principle is called the law of gravity, and it will hold good as long as no exception to it is found.

In war, there must also be some *one* governing principle, yet it must be recognized that the history of war clearly shows us that the average soldier has no conception of a law of war. Like the average man, he buys his experience, and frequently he is cheated. He sets out to fight his battles, if not actually believing in chance, very much entranced by this false goddess. In the world of science, chance does not exist. Chance is the partner of ignorance, and not of knowledge. A world ruled by chance would be a chaos and not a cosmos, and it is for this reason that so many wars in the past have been chaotic, not because they must be so, but because ignorance of the science of war has made them so.

Whether laws are defined or not, the man who would work scientifically must do so without favour or prejudice. He must be slave neither to opinion nor law. He accepts a law as long as no question is raised as to its validity, but, should doubt be cast upon it, he must re-examine it in the light of this doubt, and be ready to scrap the law if evidence proves that it is fallacious.

In the study of military history, and of history generally, the great difficulty is that the student is not examining inanimate objects but events once fashioned by human beings, and as no two men are alike, so also no two events are alike, or exactly alike. Consequently, the science of war is not an exact science. A chemist knows that two molecules of hydrogen and one of oxygen go to form water, but no soldier can definitely say, should two men fight over a jug of water, what the result will be. Yet he must know that in every fight there is a right and a wrong way of fighting. So, by either observing many fights, or by reflecting on them, by degrees he extracts what may be called the principles of fighting. Often, in his studies, he will be faced by a choice of two evils, then he must choose the lesser until further examination, or experiment, enables him to exchange an indifferent fact for a more certain one.

In war, the permanent yet the most uncertain facts are those

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related to human nature. They are permanent, since human nature changes but slowly. In all essentials man, as man, is much as he was several thousand years ago. He is courageous or fearful, greedy or generous, selfish or grateful, kindly or cruel. But which is he at any moment, and what is his predominating virtue or vice, and what is the nature of the society he lives in? It is this doubt which makes the study of history so interesting and so difficult. To study the Thirty Years' War, or the Crusades, as if they had taken place in the twentieth century is to misread history altogether, for, though the men engaged in them were much the same as they are to-day, their social surroundings were entirely different, and until these differences can be grasped, history is apt to mislead us.

The changing factors are weapons, and the means of protection and movement made use of. In recent years, weapon improvement has been continuous. To-day, the power of the bullet, the most potent factor on the battlefield, is threatened by the re-introduction of armour. This has been rendered possible by a new motive power—petrol. If, in the last hundred years, weapon-power has been advanced by leaps and bounds, in the next hundred it is likely to be changed out of all recognition, for the change of motive power from muscle to petrol is radical in the extreme. For many years yet, the soldier will live in a rapidly changing period of transition, and unless he can catch hold of the sheet-anchor of military science he is likely to become derelict to the storm.

Can such an anchor be fashioned? The answer is: Most certainly, if the soldier discovers that, though every new weapon, or improved weapon, changes the tactical use of all older weapons, yet behind all these changes there is an unchanging framework to tactics. As long as he is prejudiced in favour of a certain weapon, or arm, he will never make this discovery. He may be an infantryman, or a cavalryman, or a gunner, but he should only remain such in mind as long as these arms are useful. Not very long ago, there were no gunners; for a thousand years in Christian history, that is, over half its total period, infantry were of little use and cavalry were supreme, though to-day the tactical power of cavalry is negligible. There is nothing eternally essential in any arm save its functions; these, as controlling ideas, remain permanent, and during one period they find their expression in one series of arms, and during another in another, for arms of themselves are but the vehicles of ideas. For example: if my idea is to move from one town to another, I can go by train, car, aeroplane, horse, etc. Again, if my idea is to discover an enemy, I can use an infantry scout, a cavalryman, an armoured car, or an aeroplane. In both cases the idea remains the same, but the means of attaining it differs.

What are these functions? They are: finding, holding, hitting, and protecting. Whatever war is under consideration, whether the

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last one or the most remote, one side has had to find the other. When found, the enemy has had to be held, that is, his freedom of movement has had to be restricted. When held, he has had to be hit, and as he will undoubtedly hit back, the hitter must be prepared to protect himself.

Now, if the past 3,000 years of known warfare show us that these four tactical functions have never changed in idea, we may accept them as four scientific facts, which in the future will hold good until an exception is discovered; then we must reconsider their validity.

A close study of history will show that the side which was so organized that it could find, hold, and hit its adversary the more easily, and protect itself the more effectively, always won; consequently we may deduce from this that the controlling law of war is that of economy of force. Finding economizes time, holding economizes mobility, since the holder can make better use of his power of movement; hitting economizes energy, since the side hit will become the more exhausted, and protection economizes all these three by shielding them against being found, held and hit. If this argument is logical, then a most significant discovery has been made, namely, that war, like any other subject, is based on a fundamental law—economy of force. Accepting this law, even if only provisionally, I will now turn to the future of war and see whether, by means of it, some of its secrets cannot be read.

All sciences aim at increasing knowledge, some are concerned purely with the past, unearthing what has long been forgotten, others mainly deal with the future, and never cease struggling with its secrets. The science of war is confronted by both these tasks. The military scientist delves into past history to discover facts, and from these facts he elaborates theories as regards future possibilities. Unlike in most sciences, he cannot completely prove these theories save in war itself, yet, through logic and reflection, provisional proofs of the greatest value can be obtained; consequently, our study of military history and present-day events should primarily be undertaken with this object in view.

Our starting-point is obviously the last war, our last great experience. Before the outbreak of this war, all armies were organized for mobile warfare, as they are to-day. The War, however, proved utterly static, which at once shows that the armies of 1914 were not suited to the conditions they were called upon to face. Either conditions had been misread, or no trouble had been taken to organize armies to fit them. We know that the greatest trouble and care were taken in preparing them for the last war, consequently it is in the misreading of conditions that the fault lies.

It was the bullet on the defensive which rendered the War static, and, from 1914 onwards, the War problem was how to conquer the bullet. The obvious answer was armour-plate; but as this form of

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protection could not be carried by men, it was carried by machines, and as these machines had to move across country they were provided with caterpillar tracks. From these two facts—armour and cross-country movement—we may develop two hypotheses. The first is that unarmoured troops will prove of little use where armoured vehicles can move; and the second, that the age-old dependence of armies on roads, and later on railways, is likely to undergo radical modification, since, if one type of vehicle can move across country, there is no reason why all types should not do so. Out of this second hypothesis may be developed a third, which strategically and tactically is of the highest importance. This is: whilst in the past the decisive point of attack has normally been sought in the front of an army, in future it is likely to be found in its rear. If this is so, then our present conceptions of strategy and tactics will have to undergo a radical change. I will enquire into these three factors conjointly.

Why are infantry likely to disappear from the main theatre of war? The answer is: Because they cannot protect themselves against armoured machines. But cannot they be protected by other arms? Certainly, yet what use are they to the protecting arms? It is quite a simple operation to escort a squadron of wooden three-deckers by a fleet of modern warships, but in the eventual naval battle what use are these wooden ships?

To examine this question in greater detail: a field-gun can frequently destroy a tank, consequently field-guns can protect infantry. Now, since the bullet-swept zone compels the field-guns to come into action well in rear of the infantry they are supporting, therefore they are very badly placed to carry out this protection. Equip the infantry with portable anti-tank weapons, does not this solve the problem? No, because the tanks can stand off outside their effective range, and bring heavy fire to bear on them and the infantry they are protecting. Or they can ignore the infantry altogether and attack the guns which are covering them.

If these guns are attacked in flank or rear, they will be taken at a serious disadvantage, consequently they will require anti-tank weapons of their own. What can the tanks now do? They can ignore infantry and guns and move still further in rear and attack the supply services. These also will have to be protected by anti-tank weapons.

The problem of protection thus handled becomes an unending one, and why? *Because it is a static one.* Every unit, right back to the base, will have to be protected by anti-tank weapons, just as in the last war every unit was protected by trenches. In the War, trenches were constructed from flank to flank, and only when both flanks were blocked was complete protection established. But a trench is no great obstacle to a tank; consequently, anti-tank

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protection, as long as it remains static, will not only have to be provided for the front of a force, but also for its flanks, and it will have to go right back to the base, and only when a tank-proof lane has been established will complete protection be attained.

Literally, thousands of these anti-tank weapons will be required; and what for? To protect arms which can do the tank little or no harm. Surely then it would be better to replace the existing arms by tanks. For tank can attack tank.

The difficulties connected with this problem arise out of a faulty appreciation of facts, coupled with the obsession that the arms we have must be permanently useful. If soldiers would only think out this problem scientifically, it would at once be realized that armoured mobility can develop higher offensive power, and armoured offensive power higher mobility than unarmoured. Once realizing this, they would see the folly of the "Great Wall of China" idea. It is no economy of force to protect what is useless, and if infantry still possess certain uses, then in place of "walling" them in against tank attack, as a few years ago they were walled in against infantry attack, they must be escorted by mobile armoured troops. In conception the correct answer to this problem becomes simplicity itself directly we begin to think scientifically. Our object in war is to apply the law of economy of force, and not necessarily to hold fast to everything we have.

From what I have now written may be deduced a new theory of war, which I will call the Area Theory. In the past, movements have been linear. Troops marched in column—a line. They deployed into line, and fought in line, or lines. Generally the front protected the rear, for to outflank an unbeaten line was both difficult and dangerous. In area warfare, there is only one fixed point—the permanent base. A column may advance from this base in any direction. It can manœuvre in any direction; consequently fronts may be anywhere, and normally they will not directly protect the base, as they do in present-day warfare.

If we examine the last war we shall find that everything is pointing to this change taking place. Aircraft are independent of fixed frontages. Aeroplanes can move in any third-dimensional direction, and can attack any area within their radius of action. If this is so for attack, then defence must follow suit, areas being protected in place of points, or positions. For such a purpose, persistent chemicals at once suggest themselves. Gas is not only an area hitter, but an area protector. It not only can attack any target, even unknown ones, in an area, but can, so to say, occupy an area for days on end and remain effective.

Two other recent inventions, namely, communication by wireless telephone and telegraph are intimately connected with this same idea. To-day, it is possible to communicate anywhere in a given

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area with any other individual, in spite of the fact that his actual location may be unknown.

If the area idea is going to dominate the attack, defence and intercommunication, it follows that all the administrative services, supply vehicles, tool carts, field kitchens, ammunition wagons and ambulances must be able to move across country. When they are not immediately protected by the fighting troops they will have to be convoyed, and when distances are too long for this they will have to seek refuge in fortified depots. The picture we obtain of the future is as follows :—

A fortified base, and a series of fortified areas which are vital to the army, such as manufacturing centres. A series of fortified depots, not along the frontier, but from the frontier backwards. Escorted convoys of supply vehicles moving from depot to depot, and the fighting forces operating independently in the theatre of war. From this it will be seen how much easier it will be to fight in one's own country.

All these changes in strategy, tactics and administration, so I believe, can clearly be foreseen if present-day conditions are scientifically analysed. The law of economy of force is the controlling factor. Why be hit by a bullet if armour will protect you, and why be tied to a road if the track will enable you to move across country? For some time, no doubt, possibly a long time, if we refuse to think scientifically, infantry will be used in numbers. It may be urged, and for the time being correctly, that, as practically every theatre of war will contain areas unsuited to mechanical movement, infantry will be required. But, in wars between industrial nations, these areas, mountains and forest land, will be the least important economically. Great armoured battles will be fought on the plains, and, if won, the mountain fastnesses (under modern conditions) will soon surrender. In fact, by throttling the communications leading to them, they will be starved out. Little by little, as the true nature of conditions is laid bare, so it seems to me will armies armour themselves more and more until they are completely protected by steel. This change has occurred once before in European history, when the legions of Rome were replaced by the armoured knights of the Middle Ages. Then armies grew small, numbers of unarmoured infantry being replaced by a few armoured horsemen. This cycle, I think, is going to repeat itself, and will, so I believe, manifest when the soldier has trained his mind to think scientifically, that is when he has learnt how to apply the law of economy of force to scientific inventions and to the existing conditions of war.

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THE 23rd (FIELD) COMPANY R.E. IN THE GREAT WAR, 1914–1918.

By MAJOR R. L. BOND, D.S.O., M.C., R.E.

PART I. (AUGUST 4TH TO SEPTEMBER 5TH, 1914).

Battle Honours during the period—" Battle of Mons," " Retreat from Mons."

THE hot summer of 1914 was dragging sleepily along. Aldershot was mopping its brow in the toil of the usual summer training, the 23rd and 26th Field Companies had completed a very pleasant summer camp by the Thames at Wallingford, and as July neared its close, the field works season was almost over, and the possibilities of short leave before manœuvres were being canvassed. In connection with this field works season it is worth recalling that the problems connected with the passage of barbed wire obstacles had been much discussed, and, one fine day on the Long Valley, might have been seen the spectacle of small parties of perspiring Sappers trundling before them massive shields on wheels, whence, on reaching the entanglements before the trenches, held by the gallant (skeleton) enemy, grappling irons were thrown attached to ropes that had been uncoiled from the stomachs of the monsters in their progress. Unfortunately the wheels were small and the bumps in the valley numerous and intricate, and more than one shield fell on its face before the wire, leaving the crew limp and exposed like an oyster on its shell. This was doubtless the germ of the tank.

The only cloud disturbing the horizon was the situation in Ireland, which created a feeling of restlessness at the possibility of an unpleasant job, and it came almost as a bolt from the blue when leave was stopped on July 30th, and the full meaning of events in Europe was realized. Ireland was forgotten, and, as events followed one another thick and fast on the Continent, it became apparent that the real thing was come at last, and, little realizing the anxious and critical decisions which were being debated in the highest circles, the units in Gibraltar Barracks began to prepare for the inevitable wire. All Saturday, Sunday and Monday, there was a scene of strenuous preparation, 33 1/3 % of the 23rd (Field) Company's officers got married, harness was taken from the mobilization stores and assembled, serving soldiers were medically examined and inoculated, and all preparations made for the starting pistol.

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At 6.5 p.m. on August 4th, the order to mobilize was received, and we were already well ahead of schedule, tool carts nearly packed, harness ready for remounts, and so on. Very soon the reservists began to come in, and by the second day of mobilization every man except one had arrived, and he came a day or two later. It was not long before these men had fully shaken down ; a progressive course of route marching, beginning with 3 or 4 miles a day, and working up to 12 or 13, together with a short refresher in musketry, soon wore off the traces of reserve service, with the result that a fine, fit, hard-marching body of men marched off the Gibraltar Barracks parade ground to entrain at Farnborough on August 15th, 1914. Prior to departure, on August 11th, the Company had the honour, with other units, of being inspected by His Majesty the King.

The only absentee from the final parade was " Sunny Jim," a terribly tall yellow horse, belonging to the writer, who, having no stomach for battle, sprained a fetlock in his stable the previous day, and for the remainder of the War terrorized unfortunate recruits in the Depot. His place was taken by Peter, a well-mannered and friendly bay.

At last, 3.17 p.m., wagons and horses all packed aboard, the train steamed out, and the 23rd (Field) Company had started on its greatest adventure, conscious of the great record of service in past campaigns, the Mutiny, South Africa, every officer and man confident that that record would be maintained bright and secure in the future.

The order of battle is given in Appendix I.

The Company arrived at Southampton and detrained at 5.15 p.m., only to find that no ship was yet available, and it therefore marched to rest camp in Southampton Park. The following day, Sunday, August 16th, there was more than one false alarm that the ship was ready, but nothing happened. A church parade was held during the morning (thanks to the kindness of the Rev. H. Bown, of Southampton, who offered his services), and after parade service a very large number of all ranks of the Company attended the celebration of Holy Communion in the open air, under the tall trees of the Park ; an episode that one remembers with much gratitude.

At last, the Navy said they were ready ; but even so, to enable the most efficient use to be made of the ships, the Company had to go in two portions : Addison and four sections embarking in the s.s. *Melifont*, at 3 p.m., on August 17th ; Company H.Q. and H.Q. vehicles at 3 a.m., on August 18th, in s.s. *Basil*.

The weather was fine, but as we steamed out past the Isle of Wight, in the purple, orange and red of a wonderful sunset, there must have been a choppy sea, for in the writer's diary appears the significant entry : " The others went to dinner ! "

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During the night, the sea smoothed, and at daybreak we were all on deck enjoying an unforgettable sight, a perfect summer sunrise, as we steamed slowly into the mouth of the Seine, the red and yellow of the first rays of the sun lighting, with rainbow colours, the slight morning mist that gave dignity and an air of mystery to the steep hills above Havre, and laying on the smooth water a long carpet of gold up which we sailed into the heart of our adventure.

The valley of the Seine is very beautiful, and that early morning, steaming up the snake-like coils of the river, between the steep and rugged cliffs dotted here and there with white chalet-like houses of unfamiliar design, set in wooded clefts, left an impression that one could never forget. Early as it was, many of the country people came down to the river banks and cheered us on our way.

The *Melifont* arrived at Havre about mid-day, and moored alongside the quay, in the centre of the town. It was a blazing hot day, and the heat rose from the cobbles like a furnace, and we were not sorry when, after considerable delay for one reason and another, we eventually arrived in the rest-camp on the top of the hill, south of the town.

By 6 p.m., the H.Q. had also arrived in camp, and the Company was complete. We had been but a short time settled in, when it was discovered that a black draught-horse was missing, and a search party was sent out which after some trouble spotted the absentee tied to a gunner picket-line and enjoying a very fine gunner hay ration. Horse and ration were rapidly removed, without being spotted, which was looked on as a good evening's work by the search party.

At 9.30 the following morning, August 20th, the Company paraded in camp, and marched down to the Gare du Nord. It was a very hot day, and railway arrangements were not yet working in that smooth and timely fashion to which the B.E.F. was to become accustomed later on. There was, therefore, a long wait in the dusty vicinity of the station, and it was not until 3.45 p.m. that the train at last started on the northward journey. From time to time we stopped in wayside stations, everywhere greeted by enthusiastic inhabitants. Fair maidens filled the carriages with bouquets —Stafford, in particular, securing a fine specimen—though even the most forward bachelor of the party failed to achieve such merit as an officer of a famous regiment, who was handed a charmingly decorated card, inscribed, " Kiss me," by an attractive admirer. The nearest approach to any such stimulating greeting was a placard, held up to our carriage window by a remarkably dirty old man, accompanied by an even dirtier old lady : the legend on the placard ran, " I love you."

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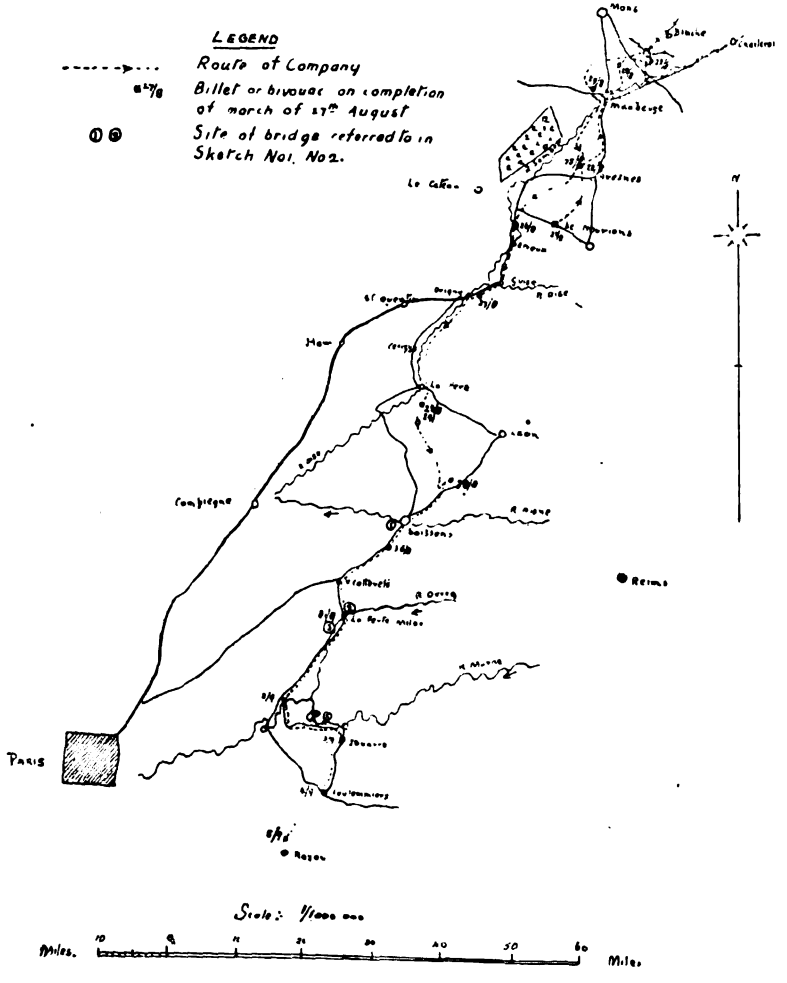
A sketch map is attached showing the movements of the Company during the ensuing operations.

About 4.30 a.m. on the 21st, in rather a chilly and foggy dawn, the Company detrained at Le Nouvion. After a halt in the neighbourhood of the station for a meal, orders were received to join the column at 12.0, and move to Dompierre, some 10 miles away. Here



the Company had its first experience of the typical farm billet: good barns; a fine meadow for the horses; rooms in the house sparsely furnished and slightly dejected in appearance; the inevitable feather mattress and *pouf* above in the heavy old wooden bed, unhygienic and not above suspicion. The wallpaper in this particular room appeared to have been in existence since the Middle Ages. However, once rid of undue æstheticism, such quarters were wonder-

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fully comfortable. Early the following morning, the 23rd (Field) Company joined in the column for its first real march of the campaign, a march forming a fitting introduction to the many succeeding strenuous days. The division moved north, along mile after mile of hard and foot-wearying *pavé* between the endless lines of poplar trees, and towards evening passed through the fortified town of Maubeuge, where the first signs of war were apparent. In the suburbs trees were being cut down, wire entanglements spread over the country on the open grass glacis before the conspicuous forts, and wire barricades were being erected on the roads. Darkness began to fall soon after passing through the line of forts, and then the first experience of night-marching in a long column. The constant halting, the pulling on another 300 yards; another halt. At each halt, marching in front of the section, one bumped into the tail of the limber of the section in front, whilst the smell of the new paint on the tarpaulin cover beat itself into the memory for ever.

At last, when the process had almost reached the limit in exhausting the troops, the Company turned in to a good orchard bivouac at Villers-sire-Nicole, at 1 a.m., having covered 21 miles. In spite of this exhausting start, there were no absentees from the ranks; a record which the unit maintained throughout the heavy marching still to come.

It had been suggested that there would be a rest next morning after the long march. Any such expectation was rudely shattered, for "R.B.," who had been to 2nd Brigade H.Q. to get news, returned later on with orders that we were to turn out again in 1½ hours' time. A somewhat hurried breakfast was achieved, and at 4 a.m. on the 23rd, the Company marched under orders of the 3rd Infantry Brigade to Rouveroy. Here instructions were received to move at once, under orders of the C.R.E., to Liseroeulx; and Bond went ahead with the C.R.E. and Adjutant (Lieut.-Colonel A. L. Schreiber, D.S.O., and Captain L. C. Jackson, C.M.G.), to reconnoitre for two strong points, facing north and north-west, in the neighbourhood of Peissant, about 4 miles south of Binche and 10 miles south-east of Mons. Two positions were selected; one about a level-crossing near Peissant station, firing north-west towards a large wood, some 1,600 yards away. This strong point included the station-master's house, which was put in a state of defence in spite of the excited opposition of the owner. The second strong point was constructed on rising ground on the east of a railway cutting, about 1,000 yards further to the south. Two sections were employed on each strong point; and trenches were dug to accommodate one or two platoons of infantry in each case. The field of fire was considerably hindered by nearly ripe standing corn, and men were employed with reaping hooks to clear it.

It may be mentioned here that there was a distinct shortage of

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6-foot rods on this day, for in the darkness and hurry of the previous night's arrival in bivouac, no proper picket lines could be arranged for the horses which were simply tied to the tool carts and limbers. We soon learnt that the hairy looks on a 6-foot rod as good for the liver, and had eaten 18 inches or so off the rods which had been left in place on the carts.

About 2 p.m., there was an alarm, and a platoon of the 2nd Welch Regiment occupied the strong points; the section of the 23rd (Field) Company withdrawing into the shelter of the cutting, where a mid-day meal was taken, much assisted by presents of vegetables, butter and milk, from the open-handed inhabitants. One or two shots passed overhead, where from it was difficult to ascertain, and from the north the occasional dull boom of a gun could be heard; otherwise there was nothing to disturb the peace of this fine summer's day. Eventually the sections withdrew and rejoined the remainder of the Company near Rouveroy, where we expected to billet. Very shortly afterwards, orders were received to move at once to Grand Reng, where the Black Watch (1st Guards Brigade) were on outpost, and the situation was unsatisfactory owing to that flank being entirely in the air. It will be remembered that the withdrawal of the 5th French Army had left a very wide gap at this point between that Army and the B.E.F. Some assistance was given to the Black Watch in strengthening the outpost position; and the Company then went into billet at Grand Reng station, actually almost in the outpost line. Luckily, no alarm disturbed the night's rest.

Early the following morning, the 23rd (Field) Company moved from Grand Reng with the 1st Guards Brigade. West of Villers-sire-Nicole the Brigade, which was forming the rear-guard to the Division, commenced to take up a rear-guard position, and a very fine one it was too, with a long, open, glacis-like field of fire to the north-east, but although work was commenced on a couple of strong points, near the Ferme de Bettignes, there was no pressure from the enemy, and it was possible to take a mid-day meal in comfort. The day was intensely hot, the local inhabitants had by now taken alarm and had almost all disappeared; and "R.B." finding in the farm two excellent casks of beer (too good to leave to the enemy) the Company had a welcome ration all round.

This was the first occasion on which the troops encountered the afterwards familiar spectacle of unhappy refugees streaming southwards by every road, and it made a deep impression. Farm carts, donkey carts, dog-drawn barrows, hand-barrows laden with the most portable property; poor old men and women making their way stumblingly along, supported by boys and girls; sometimes an old lady would be seen, sunk in the familiar bed *pouf*, being wheeled along in a barrow by a great-grand-daughter. Where they all went; how many got clear away; how many of the old ones fell by the

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way, victims at last of the aggressor whom they had faced or fled from perhaps 44 years before, who can say? It is certain that it was this scene that brought home to every man the nature of the enterprise in which we were engaged, and sowed the first seeds of that increasing bitter feeling against the wanton nation which, for the second time in 50 years, had deliberately thrust fire and sword into the peaceful homesteads of northern France. Not one of those whose hearts were wrung by that pitiful trek but can sympathize and understand when, amidst idealist cries of "Disarmament! disarmament! disarmament!" a deep strong voice from northern France replies: "No third time; security above all."

To return, however, to the story. All this long hot day, continual rumours were rife that it was going to be a near thing; that the enemy were not far off our flank, and so on; and it was obvious that the column was making a flank march across the face of the enemy. But at last, as dusk was coming on, the Company reached its billets in La Longueville Convent. Needless to say, the inmates had disappeared, and, dead to the world, tired men appreciated the comfortable quarters. The Company had now marched 20 miles on the 22nd, 12 miles on the 23rd, and 21 miles on the 24th, and dug on both the last two days. Belts were coming in hole by hole, but only one case of foot failure was to be recorded; in July, this unfortunate had been engaged in his normal duties in the Brighton Police Force.

On the morning of the 25th, a very early start was made, and just as the Company was getting on the move, orders were received for the pontoons to join the Divisional train, and for two sections to join the 3rd Infantry Brigade in the rear-guard. Numbers 1 and 2 sections were detailed for this duty, but the march produced no incident; and these sections, after becoming detached from the rear-guard and delayed by apparently endless French batteries, eventually found their way about 10 p.m., soaked and weary, to Dompierre, reporting to H.Q., 1st Guards Brigade. The remainder of the Company billeted at Houguemont, near Marbaix. On this day, the Company achieved its first casualty, for the pontoon wagons, moving with the Train, were attacked by German cavalry, and had a narrow escape. One man, probably our footsore ex-constable, was slightly wounded. The march this day was about 17 miles.

On the 26th, numbers 1 and 2 sections remained with the 1st Guards Brigade. Whilst the II Corps was fighting its great battle at Le Cateau, the 1st Division was slipping away, unmolested by the enemy. Everyone was beginning to feel the loss of sleep, and many of the unfortunate infantry, whose rest had been cut even shorter by outpost duties and night alarms, were almost marching in their sleep. Again the march of 15 miles to Petit Cambresis was carried out without molestation, though a long halt was made by the 1st

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Brigade about mid-day. We little realized the delicate situation the 1st Division was actually in at this time, although it was apparent that a big battle was in progress to the west. Food, of the legitimate kind, was very short, for the situation was such that no proper issue of rations was possible. The train wagons dumped the food by the roadside, and troops drew as they passed by. It can be imagined that the rear party found little but empty biscuit boxes, but, all the inhabitants having fled, leaving their stock to the tender mercies of the enemy, it was found that a biscuit tin made a good milk pail, and eggs could easily be found by the experts, so that no one starved. Towards the end of the day, the Company reunited and moved into billets together with the 1st Brigade, just south of the Sambre-Oise Canal, a spot that was not to be visited again until the 4th November, 1918.

The following day, August 27th, it will be remembered that the Munster Fusiliers fought their flank and rear-guard battle between Fesmy and Etreux. The 23rd (Field) Company was again allotted to the rear-guard with the 1st Guards Brigade. The bridge over the canal at Petit Cambresis was prepared for demolition, and a foot-bridge constructed alongside for the use of the rear party, as it was thought the Munsters would be withdrawing by this route. A bridgehead position was also constructed for use by troops covering the withdrawal. Heavy firing was heard from the direction of Fesmy and the road to the north. About 3 p.m., orders were received to remove the charges from the bridge and retire, and this was done, the bridge being left intact. Two companies of the Coldstream Guards were the only troops remaining when the 23rd (Field) Company eventually commenced to move southwards, and there was considerable apprehension as to the situation of the Munsters, a motor cyclist, who had brought orders to the rear party, stating that he had been unable to get through to them. After assisting by digging trenches in the preparation of a position just north of Etreux, the Company moved southwards unescorted. After leaving Etreux, an open piece of road, with a wide strip of common on either side, had to be traversed. About 1,000 yards away to the east a village was in flames, and far ahead to the south-east the smoke of others could be seen. A few mounted men suddenly galloped from the burning village straight towards the rear of the Company, followed by shrapnell shells, one or two of which burst on the road a couple of hundred yards behind the H.Q. wagons, but for some inexplicable reason no attempt was made to benefit by the remarkable target the Company, in column of route with all its pontoon vehicles, must have presented. The march proceeded unmolested until the tail of the main column was encountered struggling through the congested streets of Guise. Here an argument developed with French Staff and Engineers who wished to "*Sauter le pont.*" Considerable

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heat was generated, but the project was finally negatived, luckily for the 1st Brigade which had not yet arrived. It was not until about 11 p.m. that a bivouac at Jonqueuse was finally reached, a march of 15 miles since about 1.30 p.m.

The Company was again on the move before dawn, once more with the rear-guard. Many rumours were in the air: that the enemy were across the river, near Guise; that a great French counter-attack on the flank of the enemy, who were following up the B.E.F., was to take place; and so on. Some trenches for occupation as a rear-guard position were dug about a mile south-east of Mont d'Oriny, and successfully camouflaged with turnips. During the day, the enemy made a half-hearted effort to advance, and our guns came into action against what appeared to be cavalry on the high ground about Jonqueuse, but the advance died down. French troops appeared from the east, and after a considerable halt at a hospitable farm, where the good lady provided bacon and eggs, but suddenly decided in the middle of the frying to make a bolt for it, the rear-guard moved off. Numbers 1 and 2 sections again became detached in the course of carrying out digging work, with the result that they had a clear road for the greater part of the march, the sections marching in splendid style in spite of the heat and the fatigue of the last few days. As the Company was moving on the road east of the Oise, on the crest of a hill near Abincourt, the sound of guns was heard on the west of the river, and it appeared that a cavalry engagement was in progress, though it was difficult to see exactly what was taking place. This, we now know, was the affair of Cérizy, a red letter day in the annals of the cavalry. The march was a long one, over 24 or 25 miles, and unfortunately, just at dusk, the rapidly marching sections caught up the tail of the main column, which had just commenced the desperately fatiguing process of stopping and starting, moving 200 yards, and on again. This was too much for the weary men who had been marching so well, and a number of sappers fell out, but all arrived in the bivouac at Bertaucourt, south of La Fère, within half an hour of the remainder; and this was the only occasion during the whole of the retreat or subsequent advance on which any men fell out. Bivouac was reached about 11 p.m.

The 29th was a welcome day of rest in a splendid barn, which accommodated the whole Company. A good wash, a long sleep, letters, a full ration for nearly the first time, and by evening the Company was again ready for anything. Orders were received to move about 8.30. Major Russell-Brown was put in command of the convoy of Divisional train vehicles, with the 23rd (Field) Company, 1 section R.F.A., and 1 company of infantry as escort. The column rendezvous was St. Gobain, and about 10.30 p.m. the whole moved off through the forest, a somewhat eerie move in a bright moonlight

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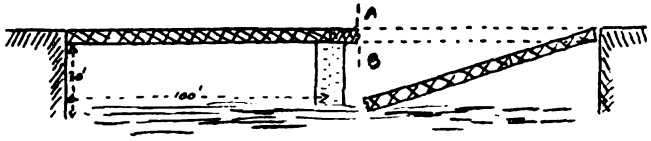
under the great beech trees. The column halted at midnight till 3 a.m. at a big convent in the heart of the forest; the night was cold, and the renewal of the march was welcome. The short rest in a wet courtyard was disturbed by occasional false alarms from the temporary outposts. Daylight found the Company marching through very beautiful wooded country. The march was uneventful, though at the end of this very hot day it was found that French troops were in occupation of the allotted billets at Margival, so that the Company moved to billets at Allemant instead, on its own initiative.

August 31st saw the Company again in the rear-guard and early

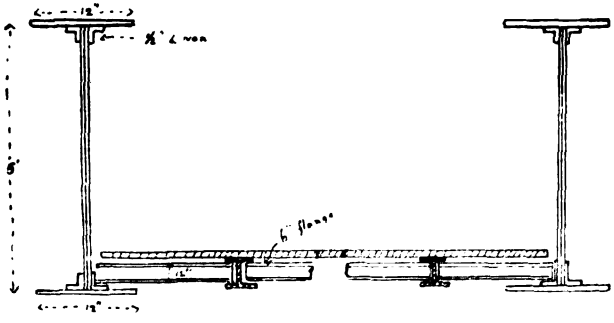
SKETCH NO. 1.

SOISSONS BRIDGE, DEMOLISHED BY NO. 4 SECTION, AUGUST 31ST, 1914.

Side Elevation.



Section on AB.



Total Charge = 12+12+12+12+3+3 = 54 slabs gun-cotton.
Fired electrically, 6 detonators in series.
Completely successful.

on the move. The march was unmolested, and the Company bivouacked in the open at Misiy-aux-bois, six miles south of Soissons. Stafford was left behind in Soissons with No. 4 section to demolish the main-road bridge, a task which was successfully carried out without interference. Sketch No. 1 gives the details of the bridge and charge.

On September 1st, famous for the fight at Nery, the Company again found itself in the rear-guard; whilst moving through the Villers Cotteret Forest, heavy rifle fire was heard at no great distance, which proved to be the enemy attacking the 2nd Division; our own rear-guard was not involved and the march was carried out in peace to La Ferte Milon, where the 23rd (Field) Company went into bivouac

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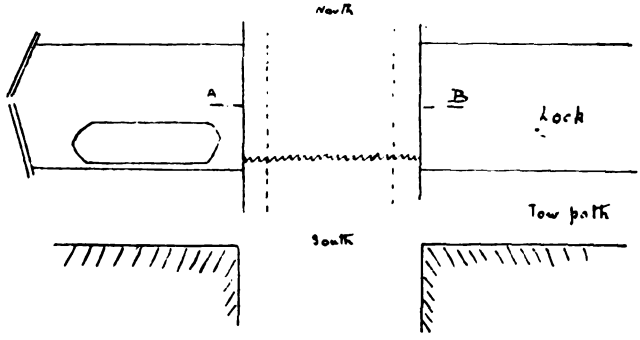
on the north side of the town with the 2nd Infantry Brigade, the remainder of the Division being south of the canal. A march of 16 miles. Shortly after reaching bivouac, the Company was ordered to assist in the preparation of the outpost position. A certain amount of digging, clearing the field of fire, and road-blocking was carried out.

It will be remembered that about 7 p.m., on the 1st September, Sir John French had decided to evade the new southerly movement of the enemy by making a night-march. As a result of this, the sections of the 23rd (Field) Company, R.E., had barely completed their

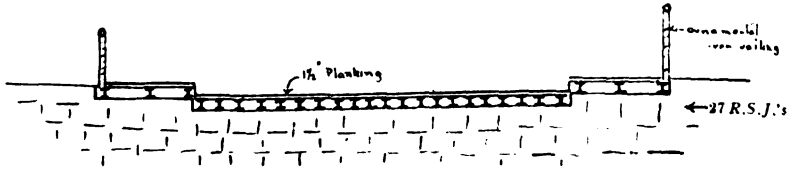
SKETCH No. 2.

Plan.

BRIDGE OVER LOCK AT LA FERTE MILON. NO. 2 SECTION, SEPTEMBER 1st, 1914.



Section on AB.



Charge. 1 slab and detonator per R.S.J. Fired in two sets of 13 and 14 charges respectively. Completely successful.

outpost work, and were just having a hot meal before turning in, when orders were received for the continuation of the move. Bridges at La Ferte Milon and at Marolles were to be destroyed as soon as the rear-guard was clear. The main-road bridge over the lock in La Ferte (Sketch No. 2) was of curious construction and required two separate sets of charges to complete the demolition. After the first set of 13 R.S.J.s had been cut, the infantry platoon escort withdrew, leaving the section officer and cyclists to themselves, very much wondering whether the rumoured Boche in lorries would appear down the village street attracted by the noise. At the same time, an irascible old gentleman in a dressing-gown and nightcap, whose house adjoined the bridge, came out with a lantern and

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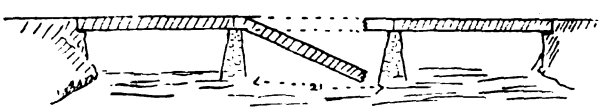
complained bitterly that his windows had been broken by the noise, and that it was most disgraceful. However, the lantern quickly went into the river, and the old man hurtled, protesting, into his house, and by 1 a.m. the destruction of the bridge was completed; a barge and some boats were sunk in the lock, spare R.S.J.s on the bank thrown into the water, but supply of explosive did not permit of damage being done to gates. The destruction of the bridge at Marolles was carried out, without interference, by No. 1 section at 11 p.m. (Sketch 3).

When the destruction parties caught up the tail of the column, some 3 or 4 miles south of La Ferte Milon, it was found that hustle was the order of the day, or night, rather. Units were decidedly mixed, the column was five or six deep, and from time to time Staff officers were passed shouting, "Keep moving! Keep moving!" No hourly halts, half asleep, mechanically plodding on, oblivious

SKETCH No. 3.

BRIDGE AT MAROLLES. NO. 1 SECTION, SEPTEMBER 1st, 1914.

Side Elevation.



Section.

Charge = 20 lb. per girder. Total = 60 lb. Completely successful.

of anything but the effort to keep going somehow, somewhere; the serried mass moved along, until, as day broke, efforts were made to collect units together, regimental representatives standing by openings into fields, calling out names of units and assembling the personnel. A long halt was made at mid-day on the high ground near Beauval, when orders were received to prepare a rear-guard position, on which some digging was carried out, but no enemy appeared and by 3 p.m. the Company arrived in billets at Varreddes, on the north bank of the Marne. Here a good rest was obtained, and a bathe. The march recommenced at 3.30 the following morning, the 23rd (Field) Company (less No. 4 section) crossed the Marne with the advanced guard, No. 4 section moving with the rear-guard, the 1st Guards Brigade. Numbers 1 and 3 sections demolished the road bridges over the river at Sammeron and St. Jean respectively (Sketches 4 and 5). The bridge at Sammeron was a fine masonry bridge, of three arches, each nearly 100 feet span. The

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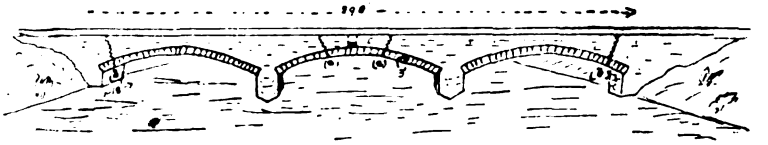
original intention was to blow a gap in the centre span, sufficient to cause considerable delay to the enemy, but not to cause too much trouble to ourselves should we re-cross the river in the course of a day or two. However, when the charge was fired and the gap made, the piers on either side were seen to be slowly settling under the thrust of the outer spans until after about three minutes the whole bridge collapsed into the stream. The night (spent at Jouarre) was disturbed by various alarms, though no enemy actually appeared.

SKETCH No. 4.

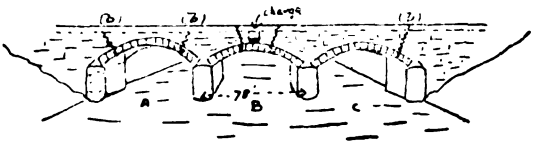
BRIDGE AT SAMMERON. NO. 1 SECTION. 6.30 P.M., SEPTEMBER 3rd, 1914.



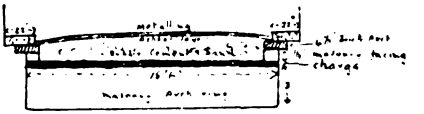
Charge = 110lb. laid in trench across roadway and tamped.
(*a*) (*a*) = limits of initial gap.
(*b*) (*b*) = subsequent break.

SKETCH No. 5.

BRIDGE AT ST. JEAN LES DEUX JUMEAUX. NO. 3 SECTION. 6.30 P.M., SEPTEMBER 3rd, 1914.



Section of roadway at charge.



Commenced at 8.30 a.m., ready at 1 p.m. Charge, 112 lb. tied to board and laid in trench. Fired electrically.
Result. Two-thirds of span B demolished; subsequently cracks developed at (*b*) (*b*) (*b*). Span C collapsed, but span A did not quite do so.

A short march, commencing very early next day, took the Company to Coulommiers. Here the Company carried out a considerable amount of work with the outposts. Numbers 1, 3 and 4 sections assisted the Black Watch on the Coulommiers-Chailly road; No. 2 section at the Pont du Moulin on the Boissy road. Here a somewhat unfortunate incident occurred. The road was blocked at the bridge over the Avenelle River by felling and entangling the branches of a fine beech tree. Unfortunately, the machine-gun, sited some 300 yards up the slope which led down to the bridge, failed to allow

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for this tree, and, when a party of German cavalry approached in the night and were duly fired upon, the bullets all found their way into the tree trunk. A party of refugees, making full-speed for Coulommiers in a taxi, had to be rescued by No. 2 section from a ditch by the bridge, and were given a lift into the town, for which Bond and Serjeant Eyres reluctantly refused the proffered *pourboire*.

On returning to Company H.Q. about 2 a.m., No. 2 section cyclists were again turned out to guide the 2nd Brigade through the town, the march having already recommenced. The Company joined the main column at Mauperthuis and marched to bivouac, a short distance north of Rozoy, where once again wiring and trench-digging on a bright moonlight night to assist the outposts was carried on. Sections turned in about midnight.

Thus finished the great retreat. The 23rd (Field) Company had never been seriously involved in actual fighting, but long marches followed by nights of digging and wiring had put a heavy strain on all ranks, particularly the reservists. However, the intensive march training of the days of mobilization had produced admirable results, and the Company can look with pride on its high record of march discipline and fitness during those anxious days.

The morrow was to show that its spirit under fire was on as high a level.

APPENDIX A.

ORDER OF BATTLE, 23RD (FIELD) COMPANY, R.E., AUGUST 15th, 1914.

Headquarters.—Commanding Officer	...	Major C. Russell-Brown.
2nd in Command	...	Captain G. H. Addison (joined on mobilization).
C.S.M.	...	W. H. Hudson.
C.Q.M.S. ...	...	A. Griffin.
Mounted Serjeant	...	W. Rapson.

No. 1 Section	...	Lieut. E. L. Parkes (Special Reserve, joined on mobilization).
		Serjeant Dominey.
No. 2 Section	...	Lieut. R. L. Bond.
		Serjeant R. Eyres.
No. 3 Section	...	Lieut. J. W. D. Mallins (joined on mobilization).
		Serjeant H. Harwood.
No. 4 Section	...	Lieut. J. H. Stafford.
		Serjeant G. Jones.

(*To be continued.*)

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WAZIRISTAN.

By MAJOR-GENERAL A. LE G. JACOB, C.B., C.M.G., C.I.E., C.B.E., D.S.O.

A Lecture delivered before the Central Asian Society on May 25th, 1927. Reprinted by permission from "The Journal of the Central Asian Society."

OUR FIRST CONTACT AND RELATIONS WITH THE INHABITANTS OF WAZIRISTAN.

BEFORE dealing with Waziristan as it is now, I propose to describe very briefly the country and our relations with its inhabitants from the time when we first came into contact with them.

To many of you here, who probably know the country as well as I do, this will not be necessary, but for those who have not been in those parts a reference to past events will make things clearer. We have here a map of the North-West Frontier Province (or at any rate of the greater part of it) which it will be as well to examine carefully.

It is merely an outline map, and does not show any of the physical features of the country, but it gives the names of the various places of importance and the communications, and also part of the Zhob district of the adjoining province of Baluchistan.

There are two lines marked on the map which are of importance, the Durand Line and the Administrative Border, which I will refer to presently.

The Administrative Border is in the plains, and practically corresponds with the foot of the hills.

The country between these two lines is a mass of mountains, not on the gigantic scale of the Himalayas, but of considerable size, many of the peaks running up to anything between 10,000 and 12,000 feet in height.

This chain of mountains runs all along the north-west frontier, through Baluchistan right down to the sea, some 2,000 miles, and is inhabited by some 300,000 well-armed tribesmen. The lower hills in Waziristan, up to a height of 4,000 feet, are very barren and desolate-looking, but the higher hills are well wooded with oak, pine, and fir trees.

The inhabitants of Waziristan consist of two main tribes, the Wazirs, or Darwesh Khel, and the Mahsuds. Although undoubtedly having a common ancestor, these two tribes are distinct.

The Wazirs, who are the stronger numerically, inhabit roughly the

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upper part of the Tochi valley, Shawal, and the country round Wana and Spin, while the Mahsuds occupy the centre.

Through this mass of mountains there are five important passes from Afghanistan into India. Commencing from the north:

1. The Khyber.
2. The Peiwar Khotal.
3. The Tochi.
4. The Gomal.
5. The Bolan.

The Khyber and the Bolan are the two most important, and have been used by armies for the invasion of India for some thousands of years, and there is now a railway through each of them.

The Peiwar Khotal came into prominence during the second Afghan War, when Lord Roberts advanced by it into Kabul after the massacre of our envoy, Sir L. Cavagnari, and his escort.

The Tochi has not been used by any modern army, either from or into Afghanistan, but it was traversed several times by Mahmud of Ghazni in his various invasions of India in the eleventh century. It is not a very difficult route. It leads to Ghazni.

The Gomal Pass, which follows the Gomal river, is fairly easy so far as the actual track is concerned, but the country through which it goes is about the worst on the frontier. This route also leads to Ghazni, but has not been used by armies for some centuries.

Both these passes, especially the Gomal, are used every year by the Ghilzai Powindahs during their migration into India in the autumn and their return to Afghanistan in the spring. They move with their wives and families and all their camels, sheep, etc.—about 70,000 human beings, and about the same number of camels, through the Gomal Pass above—and this migration takes about two months each way.

Before we came into these parts, the Powindahs had often to fight their way through the pass.

THE ADMINISTRATIVE BORDER AND THE DURAND LINE.

When we annexed the Punjab in 1849–1850, we took over all the countries which had been under the rule of the Sikhs, and, as regards the frontier, this extended only to the foot of the hills. In some places, notably the Bannu district, their rule was only nominal.

Their only method of collecting any revenue from it was by sending periodically a small army there, which looted and destroyed, but it ended generally in their being chased out of the country by the exasperated inhabitants without any revenue.

In the district further south, now the Dera Ismail Khan district, their rule was less shadowy. Raiding by the tribesmen from the hills was constant, but the Sikhs only once attempted to enter the hills and were only too glad to come out again.

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After annexation, we took over charge and established garrisons and administered the country right up to the foot of the hills—taking revenue from the people—and this is, practically speaking, our administrative border now. Although we have garrisons in the hills and in many places beyond it, we do not "administer" or take revenue beyond it.

Most of you know what the Durand Line is, but, for the benefit of those who do not, I will explain it very shortly.

The mountains all along the frontier are inhabited by various tribesmen, such as Mohmands, Swatis, Bajauris, Afridis, Orakzais, Wazirs, Mahsuds, etc., who have always been immensely proud of their independence, and acknowledged neither the Amir of Afghanistan nor the British as their rulers, and who look upon the various phases of frontier fighting as their normal existence.

Although all alike in their spirit of independence, they are not alike in their tribal constitution and idiosyncrasies. They are all Pathans, and are allied in language and religion to the Afghans, but not in race affinity, except, perhaps, the Mohmands.

They have not the faintest race sympathy with India or the ruling people of India, but all of them would appeal to the Amir of Afghanistan as adviser and supporter. If he has not been their king, he has been their religious chief and their political referee.

It was extremely easy, therefore, for the Amir to stir up these tribesmen against us if ever he wished to make himself unpleasant and to give us trouble.

In 1893, relations with the Amir had been strained for some time. Among other reasons he was very sore about our selection of New Chaman as the site of the railway terminus on the far side of the Khojak. He considered that we had gone too far down into the plain, and had violated the Treaty of Gandamak. On the other hand, we had various complaints against him for aggression, so negotiations were made for a mission to proceed to Kabul and definitely fix with the Amir our respective spheres of influence. Sir Mortimer Durand, at that time Foreign Secretary to the Government of India, was our envoy, and after some months succeeded in getting the Amir to sign the agreement. The line you see on the map was agreed to, and it has been called the Durand Line after Sir Mortimer Durand. Except in a few places, which it was impossible for our parties to visit, the whole of this line has been marked out by pillars.

Expeditions into Waziristan.

I will now mention very briefly the various expeditions which we have had to carry out from time to time against the tribesmen in Waziristan. Raiding has always been looked upon by the trans-border tribesmen as a normal condition of existence, and as a legiti-

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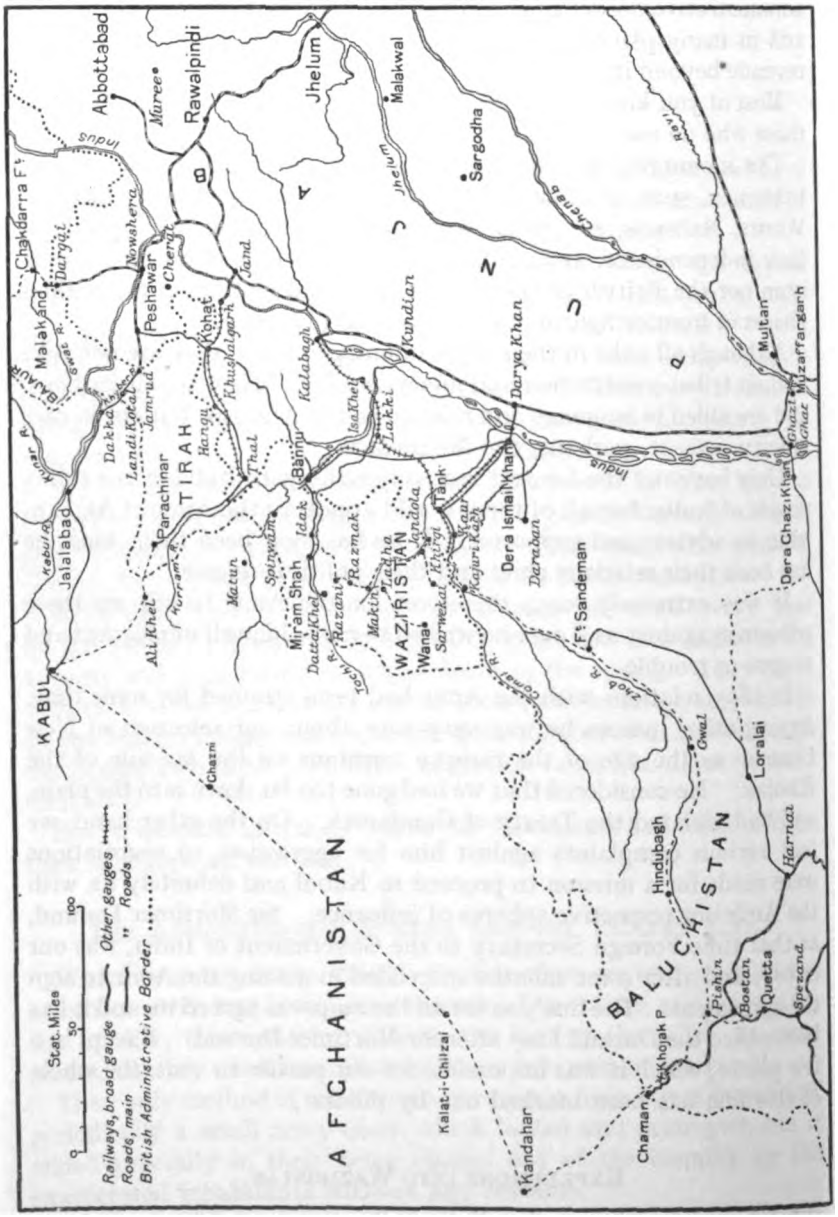
mate source of income. In this respect, raiding, temptation with these border people lies all on the side of India. Their own lands are



barren and rough, and cultivation is confined to the narrowest strips of alluvial soil which may be found alongside their mountain streams. In fact, their own country is not self-supporting, and up to recent

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times they looked to raiding and looting the plainsmen to increase their means of subsistence. They are born with the instincts of the old Scottish Border robber in them, and the fat plains of the Punjab were their traditional hunting grounds. After taking over from the Sikhs, we very soon came into conflict with both the Mahsuds and Wazirs. The result was our first expedition against the Mahsuds, in 1860, under General Sir Neville Chamberlain. Those were the days of muzzle-loaders, and the Mahsuds trusted chiefly to shock tactics, especially attacks on a camp just before dawn. They made one of these on our camp at Palosin, near Jandola, and managed to get in, but were beaten off with considerable loss on both sides. There was also some severe fighting at the Barari Tangi, but our force went through the country, brought the Mahsuds to terms, and then withdrew from the hills.

Except for occasional raiding, matters remained comparatively quiet for some years, but, towards the end of the second Afghan War, in 1880, the Mahsuds and Wazirs came out of their hills in strength and sacked Tank (about nine miles from the nearest hills), and, in the spring of 1881, an expedition under General Kennedy started in two columns, one up the Takki Zam from Tank to Kaniguram, and the other up the Khaisora valley, with Razmak as its objective. There was some desultory fighting, and various villages and towers were destroyed. The Mahsuds and Wazirs came to terms, and the force again retired from the hills to their cantonments in the plains.

The next expedition, the third, was in 1894–1895. Shortly after the Durand Line had been agreed to, the Government of India decided to form a military post at Wana. The Amir had built a post there shortly before this, but had been obliged to withdraw the garrison in accordance with the Durand agreement.

Wana is some twenty miles from the Durand Line on our side of it, and its strategical importance had been recognized by both our political and military authorities for the following reasons :

A military force established at Wana is in a position (*a*) to stop Afghan emissaries and troops from entering that area from Birmal ; (*b*) to dominate the Sulaiman Khel and other Ghilzai tribes who enter our territory every year by the Gomal river route ; (*c*) to check both Mahsuds and Wazirs from raiding in the Zhob district.

It was decided to occupy the place with a brigade of all arms, and incidentally to use this force as a support, which was considered essential to the actual demarcation of the Durand Line west of Waziristan.

This brigade arrived at Wana in 1894, and encamped in the open plain. Here they were attacked by a combination of the Mahsuds and Wazirs just before dawn. The enemy managed to penetrate the camp, and a fierce hand-to-hand fight took place in the dark. They were eventually driven out by the bayonet with heavy loss, and as soon as it was light enough to see, the cavalry were let loose,

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followed by infantry and guns, and the tribesmen disappeared into the hills.

This led to the expedition of 1894–1895 under General Sir William Lockhart. Again our troops went right through the country, and the Mahsuds came to terms. Then was our opportunity to occupy Mahsud country, and the Mahsuds were prepared to accept it. There was at that time scarcely a single breech-loader in the country, and occupation could have been followed by gradual disarmament without much difficulty, but again we cleared out.

However, we occupied Wana in Wazir country, and its effect was very soon apparent. Raiding into the Zhob district of Baluchistan almost ceased, and it was found possible to reduce the strength of the garrisons and outlying detachments by nearly one-half.

The force eventually kept at Wana after the demarcation of the Durand Line was one battalion of infantry, one section of mountain artillery (two guns), and one squadron of cavalry.

Before this occupation of Wana, the route through the Gomal Pass, from Kajuri Kach to Murtaza, had been opened in 1891 by Sir Robert Sandeman, A.G.G., Baluchistan.

There was thus communication to Wana through this pass from the plains and also communication with Zhob along the Zhob river from Khajuri Kach.

About the same time, the Tochi valley had been occupied, our most advanced post being at Datta Khel at the head of the valley.

Except for occasional raids, the country was more or less quiet for a few years. Then came the treacherous attack on our troops at Maizar, about ten miles beyond Datta Khel, in 1897, resulting in the expedition against the Wazirs, but with very little actual fighting.

THE WAZIRISTAN MILITIA CORPS.

In 1900, the Government of India decided to raise two local militia corps in Waziristan, to take the place eventually of the regular troops located there. One, the North Waziristan Militia, to be located in the Tochi valley, and the other, the South Waziristan Militia, at Wana and along the Gomal route. Local militia had been tried with success elsewhere along the frontier, notably in the Kurram valley, but the position there was very different from that in Waziristan.

The inhabitants of the Kurram valley, the Turis, were only too glad of our presence and support in their valley, as they were surrounded on three sides by hostile tribesmen, so they joined the militia freely and worked with us.

That corps, the Kurram Militia, was in actual fact what it was intended to be—a corps locally recruited and for local service, and it answered admirably. In Waziristan, on the other hand, it was extremely risky to enlist Mahsuds in large numbers; we were not

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occupying a single yard of their country, and had therefore very little control over them. Moreover, one of the main duties of the militia would be to intercept raiders, and most of the raiders were bound to be Mahsuds. The case of the Wazirs was slightly different; we were occupying a good deal of their country in the Tochi and at Wana, and we had therefore some hold over them. A good number of them were enlisted and did well.

We tried the experiment of enlisting Mahsuds at Wana, the headquarters of the South Waziristan Militia, and at one time we had about 500 of them—about one-third of the strength of the corps—but it was not a success. They got out of hand, made a plan to seize the headquarters post at Wana, which very nearly succeeded, and they incidentally murdered the commanding officer, so they were all discharged. With the exception of a small number of Wazirs, the corps eventually consisted of other border tribesmen, such as Afridis, Orakzais, Khattaks, etc., and was not locally recruited.

Shortly after the raising of these two militia corps had commenced, the Mahsuds, whose offences in the way of raiding and other outrages had been mounting up, were fined, as a tribe, a lakh of rupees. They were given a month in which to pay up, failing which they were to be blockaded. Needless to say they didn't pay up, and the blockade started in December, 1900. This lasted nearly a year, was not successful in bringing them to book, and another expedition—the fourth—was carried out against them. This was in the winter of 1901–1902, and again we went through their country.

The fighting was not severe, and a lot of destruction of villages and towns was carried out as before.

Here again was our opportunity to occupy their country, and again we declined to take it and cleared out. Meanwhile, the Mahsuds had become very much better armed. More than one-third of their fighting men had breech-loaders by this time.

In 1904, the two Waziristan militia corps relieved most of the regular troops in Waziristan, and the situation remained more or less quiet until the outbreak of the Great War.

Our position then in Waziristan was this: We occupied the whole of the Tochi valley on the north, and the Gomal route up to Wana on the south side. The east side had always been held by us, but the west towards the Durand Line was entirely open, and both Mahsuds and Wazirs had free communication with Afghanistan whenever they chose. Not a single part of Mahsud country was occupied by us.

Enlistment of Mahsuds in the Indian Army.

In the early 'nineties, Mahsuds had been enlisted in one of our Indian regiments, the 124th Baluchis, up to the strength of one company

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—114 men—and about ten years later, in 1903, a company of Mahsuds was raised in the 130th Baluchis.

Both these experiments proved successful, and in 1910 it was decided to raise two additional companies in the 130th, and three companies in each of the 127th and 129th Baluchis. There were thus at the outbreak of the Great War, in 1914, ten companies of Mahsuds altogether in these four Baluch regiments—about 1,050 men.

Many of these Mahsuds served in France and East Africa during the Great War and did extremely well.

As was the case among other trans-border tribesmen enlisted in our Indian Army, notably the Afridis, disinclination to serve (to put it mildly) became apparent, and it ended in the discharge of practically every trans-border Pathan in our Indian Army; up to then the situation in Waziristan was more or less normal, but, in 1916 and 1917, serious trouble broke out—and we had few reliable troops with frontier experience to cope effectually with it. In 1919, the crash came.

When the two Waziristan militia corps were first raised in 1900—I happened to be one of the officers first appointed—it was always impressed upon us that we should never be left in the lurch, and that we could always count on support by regular troops in time of trouble.

RETREAT FROM WANA, 1919.

However, in 1919, when real and very serious trouble occurred, no support was forthcoming.

The commandant of the South-West Militia at Wana, Major Russell, a very gallant officer, received instructions by telegram that he could not receive any support, and that he could hang on to Wana or clear out as he thought best. I cannot imagine any officer being placed in a more unfortunate position. He could have hung on to Wana for possibly a month until his supplies gave out—water would not have been any difficulty, as there was a well in the fort—but, by that time, the whole country would have been up, and retreat would have been almost impossible. He wisely decided to clear out while there was still time. He had no transport, and he and his officers and men had nothing but what they stood up in. He decided to retire quietly during the night, and his only line of retreat was to Toi Khullah, twenty-eight miles, and thence into Zhob. Some 200 Afridis of the Corps, who happened to form part of the garrison at headquarters at Wana at the time, turned traitors and fired on the others. So the retirement was hampered from the very start. To cut a long story short, the unfortunate remnants of the Corps, some 300 or 400, eventually straggled into Fort Sandeman, having had to

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fight their way down for about fifty miles before they got clear. Major Russell himself was badly wounded, and nearly all his British officers were killed.

Effect of Evacuation.

You can imagine the effect of this evacuation of Wana in the country round.

Afghan emissaries and troops almost at once came in from the Birmal direction. The Wazirs joined in with the Mahsuds, and practically the whole of Waziristan was up.

I have already mentioned the strategical importance of Wana, and our abandonment of the place at once had its effect.

Strong parties of raiders, both Mahsuds and Wazirs, at once started operations in Zhob, and at one time Fort Sandeman itself, the headquarters of the Zhob district and about a hundred miles from Wana, was besieged for some days. The troops in these parts had to be reinforced—to about double their former strength—and all their work had to be carried out as on active service in an enemy's country, where formerly all had been quiet and comparatively peaceful.

We were then compelled to carry out operations against the Mahsuds at a most inconvenient time. The Great War was just over, most of our regiments in the Indian Army consisted of mere recruits with no frontier training and experience, and their British officers, with a few exceptions, were much the same.

We organized what in former years would have been considered a very large force, and more than adequate to deal with the situation, but, before the Great War, we had many very fine regiments thoroughly well trained in frontier warfare, both officers and men, and up to all the tricks of the game. Now, in 1919, we had to rely on quantity, not quality, and, to add to our difficulties, there must have been something like 2,000 Mahsuds against us, who had been trained by us—about one-fifth or one-sixth of the fighting strength of the tribe. Nearly every Mahsud had a modern rifle and knew how to use it, and he was on his own ground, with every inch of which he was familiar; whereas in the expedition of 1901–1902 our troops, well trained and able to shoot well, plastered the Mahsuds with lead up to 800 yards every time they showed themselves, now the boot was on the other leg. Many of our troops had not even fired a recruits' course with their rifles, and it was *our* men who got the plastering; the result was the biggest butcher's bill on the frontier, our casualties being over 2,000.

Re-occupation.

However, we won in the end, and this time we fortunately did not clear out of the country. We occupied strongly with troops the line up the Takki Zam to Ladha, close to Kaniguram, and proper road con-

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struction for motor transport was carried out. The South Waziristan Militia was reorganized at Jandola, and renamed the South Waziristan Scouts.

I may mention that the withdrawal from Wana also entailed the evacuation of all the other posts held at that time by the South-Waziristan Militia and the complete abandonment of the Gomal Pass, which we had held for nearly thirty years.

It was a very heavy blow to our prestige, from which we have not completely recovered. At the same time as the withdrawal from Wana took place, the commandant of the North Waziristan Militia was ordered to abandon Datta Khel and the other posts in the Tochi valley above Miram Shah held by the militia, and actually also to burn them on retirement. Imagine the effect of this on the local tribesmen of the country round and on those enlisted in the Corps. They could only think one thing—and that was that we were "down and out." Things were comparatively quiet for some time after the expedition of 1919–1920, chiefly because we were in occupation of the country or, at any rate, of part of it—but there was a distinct feeling of unrest, owing to the delay in the decision of the Government of India as to whether we intended definitely to remain or to clear out. Fortunately, Government decided to retain troops in the country; and then came the question of the best place for locating these troops in order to dominate the Mahsuds. Razmak was the place decided upon.

RAZMAK FIELD FORCE.

In the autumn of 1922, the Razmak Field Force was formed from the troops of the Kohat district, with orders to occupy Razmak and form a strong movable column capable of operating in any direction from there.

FRONTIER ROADS.

This operation was duly carried out, and the Razmak plateau was occupied in January, 1923, in a blinding snow-storm; at the same time, a good metalled road fit for heavy mechanical transport was constructed, branching off from the existing road up the Tochi at Isha and thence all the way to Razmak.*

From Razmak this road has been continued, and now joins up with the road from Jandola up the Takki Zam, so that you have a circular motor road now running from Bannu up the Tochi, right through the heart of Waziristan, down to Jandola, and then on to Dera Ismail Khan in one direction, and to Sarwekai to the west.

* For an account of the construction of this road, see *R.E. Journal*, September, 1925, pp. 361–379. The road as far as Razani was constructed ahead of the regular troops, under the protection of *Khassadars* only.—*Ed., R.E.J.*

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Razmak itself is an excellent place for a cantonment—6,500 feet in height and a good climate, about five miles from Makin. The garrison is a large one, consisting of three pack batteries, one section medium artillery (6-inch howitzer), one company, S. and M., six battalions of infantry, and one battalion pioneers; and the movable column from this force consists of two pack batteries, four battalions infantry, one battalion pioneers, and one company S. and M. I will now deal with the present situation and our future policy in Waziristan.

Policy and Present Situation.

The present situation is this: we have a large force at Razmak with a strong movable column, which dominates the Mahsuds to a great extent; but there are certain sections of the tribe which this column cannot reach at present without a lot of additional pack transport. It is equipped with M.T., A.T. carts, and a certain amount of pack-mule transport, and it can move anywhere along the circular road and up to Sarwekai, and it can also move to Wana when necessary, as it did last year, and in the opposite direction from Razmak into the Tochi up to Datta Khel. It can also strike at any tribesmen within a day's march of the metalled road; but there are two important parts of the country which it cannot reach without pack transport —*i.e.*, camels—and they are (*a*) the Shaktu valley, and (*b*) towards Kaniguram and the Khaisara valley.

The road itself, from Bannu right round through Razmak and Jandola and thence to Manzai in the one direction, and to Sarwekai in the other, is strongly held by regulars, scouts, and *Khassadars*.

The present policy is, in my opinion, thoroughly sound, but it must be continuous and progressive.

What we have suffered from in the past is a lack of continuity in our policy, or rather a lack of any policy at all. We blew hot and cold alternately, with no practical result so far as the pacification of the country was concerned.

We should, therefore, continue our present policy steadily and progressively, and the next step in our progress should be the reoccupation of Wana, and the sooner this is done the better.

On a frontier which consists of a chain of mountainous country like our north-west frontier, one of the most essential and important things is good lateral communications, so that troops and supplies can be moved without difficulty where and when required. At present, there is no lateral communication by road between Waziristan and the Zhob district of Baluchistan, although the two districts are adjoining: there used to be, before we withdrew from Wana.

In this connection there is already a narrow-gauge railway from Khanai (about thirty miles north of Quetta) to Hindu Bagh, and I have reason to believe that an extension of this railway from Hindu

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Bagh, down the Zhob valley to Fort Sandeman, has now been sanctioned. It seems natural and obvious, therefore, that this railway should eventually be continued down the Gomal valley to Tank, where there is a similar narrow-gauge railway.

I have already mentioned the strategical importance of Wana and the effect of its occupation.

Now, since our withdrawal, there is a big gap in our line of about forty or fifty miles, exposing the Zhob district from the north and west, and communication by road has ceased to exist.

The reoccupation of Wana would at once close this gap, and automatically cause a reduction in the number of troops which it is now found necessary to keep in the Zhob district for its protection. In fact, that fatal withdrawal in 1919 has put us back thirty years in that part of the country.

Our next obvious step, therefore, it seems to me, should be (*a*) the occupation of Wana; (*b*) construction of a metalled road fit for mechanical transport from Razmak to Wana; (*c*) extension of the road from Sarwekai to Wana; (*d*) a branch from this road to Khajuri Kach and thence to Fort Sandeman.

If the above be carried out, our hold on Waziristan would be complete: Wana should be held by regulars.

It would not mean any addition to the troops now in the country. The garrison I recommend is one squadron of cavalry, three battalions of infantry, and one pack battery, all from the Manzai Brigade. We are not committed to any serious building programme yet at Manzai, and the troops could be hutted at Wana just as easily as at Manzai, and in a far better climate.

The regular troops in Waziristan would then be concentrated in the two most important places for dominating and holding the country as regards both Mahsuds and Wazirs.

The soundness of our present policy is to my mind apparent. It has resulted in peace and quiet during the past two years, such as was unknown before, and if we continue this policy steadily and progressively on the lines suggested, the gradual disarmament of the tribesmen will most assuredly follow. It is merely a question of time.

The Mahsuds are undoubtedly settling down, and are recognizing and reconciling themselves to the fact that we mean to stay.

There will be no opposition to our reoccupation of Wana from the Wana Wazirs, and as regards a road from Razmak to Wana *via* Kaniguram, the Mahsuds are already beginning to ask about contracts for work on the road, as they are convinced that this is bound to come.

The civilizing effect of good roads is apt sometimes to be lost sight of.

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What we are doing now in Waziristan is exactly what was done in the Highlands of Scotland nearly two hundred years ago by General Wade when he made a road right through them, and the effect will be the same.

The pity of it is that it was not done thirty years ago, when we had the chance, and when the tribesmen were badly armed. We should have saved ourselves a vast amount of blood and money.

Additional Notes up to March, 1928.

During October, 1927, the Manzai Column marched to Wana, where it halted for three days, during which tribal allowances were paid by the local Political Officer. It then returned to Sarwekai, and the Razmak Column, which during the same period had marched to Dargai Oba, returned to Razmak. The whole operation was carried through without any tribal opposition, and the serene atmosphere throughout Waziristan continues to vindicate the present policy of peaceful penetration and road construction.

As regards the road programme, the Razmak–Jandola road is being improved by the substitution of permanent for temporary bridges and the Sarwekai–Wana road is now being constructed by tribesmen under contract. In addition, work on the Tochi–Thal (Kurram) road is in progress, and the Kaitu River is being bridged at Spinwam.

Last cold weather, there were several incidents between the Powindahs and the Wana Wazirs during the former's migrations, and the Wazir villages on Spin were burnt. This year, the Sulaiman Khels passed down to British India without any trouble at all. The Dotannis started to graze on Spin, and a party of Scouts was sent out to deal with them, which it managed most successfully.

The situation has been very quiet during the last year, only a few minor incidents having occurred. Meanwhile, the tribesmen are becoming more and more amenable. In September, 1927, the Political Agent, South Waziristan, escorted by a number of Mahsud *maliks* and *Khassadars*, climbed Pir Ghal, the highest mountain in Waziristan. It is believed that this is the first time a European has reached the top.—Editor, *R.E. Journal.*

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THE NEXT GREAT RAILWAY.

By LIEUT. C. A. DE LINDE, R.E.

Note.—On January 11th, 1928, the French Minister of Public Works wrote a circular letter to the interested parties stating that the Prime Minister had approved the formation of a Trans-Saharan Committee; that this committee would have a sum of £100,000 allotted to it, wherewith to carry out the survey of the line. A third of this sum will be found by the State and the rest by the Colonies and Private Railway Companies concerned. Parliament will be asked to pass a Trans-Saharan Bill this session. The survey should be completed by April, 1929.

THE Great War, with its Armies' ever-increasing cries for more soldiers, more labour and more material, has given the French people a new idea of the value, actual and potential, of their colonial empire. What before the War was only known to a few far-sighted travelled Frenchmen, such as Marchand, Gallieni, Archinard, Mangin and Lyautey, is now known to many a man in the street. As Britons, we generally use atlases published in London or Edinburgh, and our eyes are naturally taken by the large areas coloured red, rather to the exclusion of other less brilliant colours. But a glance at a French atlas will show that there is another colonial empire besides our own; an empire not so large, not so populous, not so rich, not so temperately placed, not so fully developed nor so colonially minded. Still Indo-China, Madagascar, North Africa, West Africa and Equatorial Africa make France the second colonial power of the world.

It is with the object of welding the last three into one strong whole that the world's next great railway will be built. Since the Treaty of Versailles restored to France a slice of Central Africa behind the Cameroons, these three great areas have been contiguous, but have had no real unity. And the two last, West and Equatorial Africa, are not the pillars of strength they should be. France sees the remedy in a Trans-Saharan Railway, to which in time will be added a great limb, growing eastwards and southwards round Nigeria to the Congo basin. With the advances, made and still continuing, in North Africa, the French are well and justly content; the flag has already been followed by trade, and civilization comes hot-footed.

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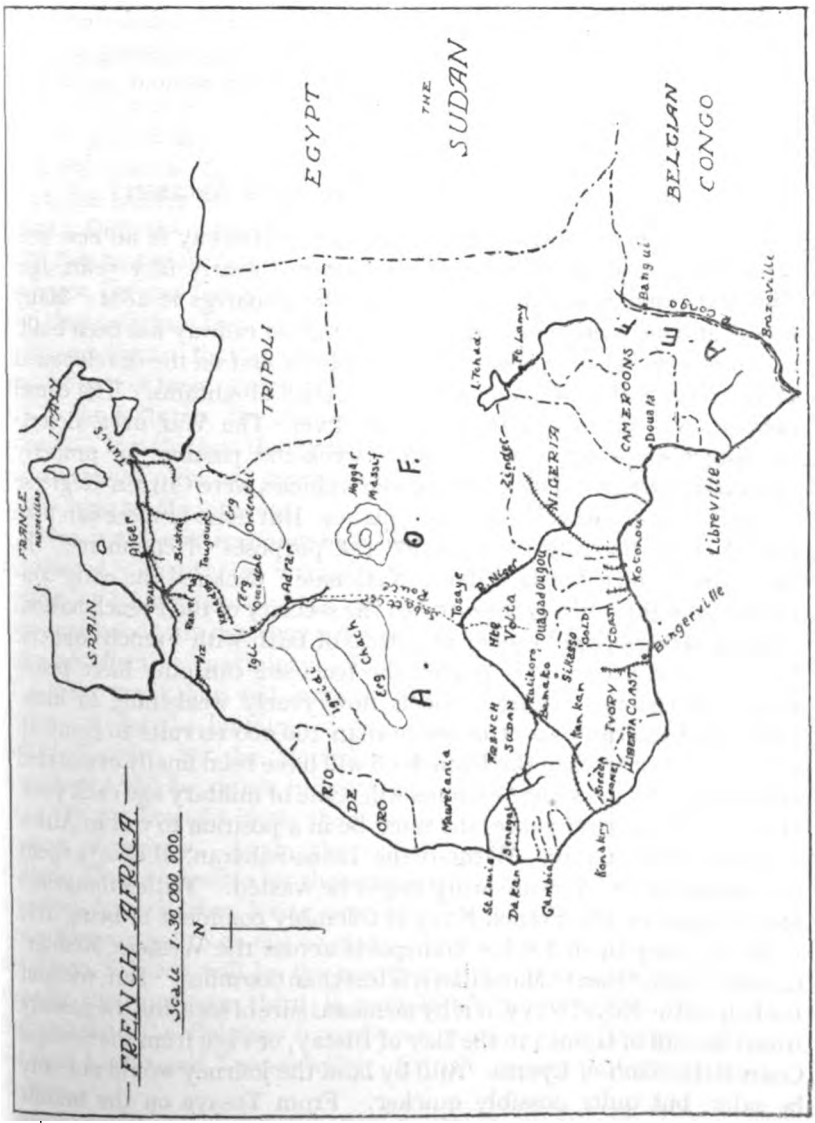
The Geography of French Africa.

A study of the map is essential to a right understanding of the matter. French North Africa (Afrique du Nord) consists of the



Colony of Algeria and the Protectorates of Tunisia and Morocco. The pacification of Morocco is almost complete. French West Africa (A.O.F. or Afrique Occidentale Française) consists of four coastal colonies—Senegal, Guinea, Ivory Coast and Dahomey, all separated each from the other by foreign territory, but with a common

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hinterland in the colonies of Mauretania, French Sudan, Niger and the Upper Volta. French Equatorial Africa (A.E.F. or Afrique Equatoriale Française) stretches along the north-west banks of the Congo and the Oubangui from the sea to Lake Tchad, from the Chari to our Sudan. Togoland and the Cameroons are administered by France under a League of Nations mandate. The existing railways are all of the sort that run inland from the coast without any lateral connection.

THE TRANS-SAHARAN AS A MILITARY NECESSITY.

The project of building a Trans-Saharan Railway is no new one. Money was first voted for a reconnaissance nearly fifty years ago. The first mission was assassinated by the Touaregs in 1881. Many reconnaissances have been made since, but no railway has been built, as it was considered desirable to concentrate first on the development of the more valuable lands under the Atlas Mountains. The camel caravan was given a little longer to live. The War over, desert-crossing became little more than a week-end pastime for properly organized parties. The most popular vehicles were Citroen-Kégresse tracked cars, six-wheelers and aeroplanes. But none of these can take the place of the railway train for the purposes of commerce. In 1923, the " Conseil de la Défense Nationale " declared the early construction of this railway essential to the security of the French nation. This declaration has become an article of faith with French soldiers. France's first necessity is peace; she feels she can only have peace while she remains strong. She is now yearly weakening in man-power and she can expect no more than 160,000 recruits to come up in 1935, at a time when the Rhineland will have been finally evacuated and some 500,000 young Germans will come of military age each year. Hope as she may for peace, she must be in a position to call in Africa to redress the balance. Without the Trans-Saharan, all efforts spent on organizing an African army might be wasted. With submarines and aeroplanes, the French Navy is tolerably confident of being able to keep a way open for her transports across the Western Mediterranean—from Oran to Marseilles it is less than 600 miles. But, without the help of the Royal Navy, it is by no means sure of securing the passage from the Gulf of Guinea to the Bay of Biscay, or even from the Senegal Coast to the Gulf of Lyons. And by land the journey would not only be safer, but quite possibly quicker. From Tosaye on the middle Niger it takes from three to five weeks—according to season—to Marseilles. By railway it should take less than a week—at all seasons. Though, perhaps, large forces could not be transported at this rate, it is hoped that with a clear run across the desert and good operation, a steady schedule speed of thirty miles an hour will be possible for every type of train. This would mean an enormous

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increase of capacity over what has been hitherto found possible on single lines with expresses averaging forty miles per hour and mineral trains just managing to average ten. It remains to be seen, however, how far it will be possible to work one-speed trains in practice.

Economic and Political Advantages of a Trans-Saharan.

Further, it is economically important to France, as to any other Power, to be in the greatest possible measure self-supplying, in peace as in war. In war, because Mars has found to-day a new appetite, an insatiable hunger for dishes made up of rubber and oil, cotton and wood. Only the nation well equipped with factories and well supplied with raw materials from the tropics can hope to satisfy this hunger. In peace, because industrial countries can only balance their accounts and thus maintain their standards of life—when their foreign imports are a minimum, that is when they can supply themselves with a greater part of their raw materials. And the nearer the raw materials are to the factories, the cheaper and more saleable are the finished articles. It is this last that will make French Africa, when adequately endowed with railways, more important to the mother country than Indo-China or Madagascar.

There is the political and social importance of the line also to be considered. Rightly or wrongly, the French favour a centralized system of government. This can only succeed where communications are good; as yet they are poor in French Africa, in that they have no effective continuity. It is felt, too, that the construction of a great trunk line will increase French prestige, in Europe as in Africa; so far the building of such has all been carried out by the British Empire, by the United States and by Russia. Its social importance will be rather indirect, but none the less real; railways have always brought with them peace, peace has generally in its retinue prosperity. Again the railway will make more frequent visits to France possible for the utter exile that almost every Frenchman feels himself when living overseas. With it he may be the more easily encouraged to go out to make a new France in Africa. Lastly, the Trans-Saharan will be the northern third of the Trans-African; already the southern third is completed between the Cape and Bukama, and the Belgians have begun work on the central portion between Luebo and Leopoldville. British interest in such a line is obvious.

The Proposed Route.

At least half a dozen routes have been carefully reconnoitred between the Niger and Algeria, and it is now generally agreed that that of Sabattier will be best. It makes Oran the northern terminus and Ouagadougou (*anglice* Wagadugu) the southern, and takes the line through Kenadsa and Adrar to cross the Niger at Tosaye. It is to be

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noted that there is already a line from Oran to Colomb-Béchar near Kenadsa, but it is narrow-gauge and has very sharp curves that would make conversion difficult. From the present broad-gauge railhead at Ras-el-Ma, south of Oran, it would go fairly straight through easier country to the coalmines of Kenadsa. Then by following the Souara valley it would avoid the Erg Occidental—a sterile sandy desert—on one side, and the dunes of the Iguidi and of the Erg Chach on the other side. Beyond the Touat oases, it will follow a tolerably straight course, leaving the Hoggar mountains well to the East. At Tosaye the Niger runs between rocky banks, and is no more than six hundred feet wide. In the more distant future, the great limb to A.E.F. and the Cape is expected to leave the Trans-Saharan here and to go round Nigeria (through Zinder and Fort Lamy) to Bangui, which would be the natural terminus of the Congo system. From Tosaye to Ouagadougou it is less than four hundred miles across the potentially rich region enclosed in the great sweeping bend of the Niger. Ouagadougou may expect to become the Clapham Junction of West Africa, whose coast is convex to the sea and whose existing railways run perpendicular to the coast in such a way that their natural extensions will lead to this, the capital of the Upper Volta. Indeed, these lines have been laid with a view to ultimate through-connection to the Mediterranean. They will become feeders to the Trans-Saharan as well as the bonds that will make, one day, a genuine entity of A.O.F. The hinterland in that day will no longer be a hinterland, but a centre of production and commerce, looking as much to the north as to the south or west. There are many sections remaining to be completed —the task is ambitious, but scarcely Utopian. In Senegal, the main line has to be taken from its present rail-head at Koulikoro *via* Sikasso to Ouagadougou. The Guinea railway will have to be continued from Kankan to either Sikasso or Bamako, the Ivory Coast Railway from Niangbo to Bobo. Finally, there will be the terminus of the Dahomey line at Savé to join to the rest of the system at Ouagadougou. It must be understood that there is no chance of all these missing links being forged much, if at all, before the Trans-Saharan itself reaches the Upper Volta ; work on them, though fairly constant, is slow. They are all metre gauge.

In A.E.F., lines are eventually likely to run from Bangui to Douala (the Cameroons), Libreville (Gabon) and Brazzaville (Middle Congo). Belgian Congo and A.E.F. lines are all three-foot six-inch gauge to match the South African Railways.

INTERNAL SECURITY.

The Sabattier route has, moreover, this to recommend it, that it is the safest. It avoids, more successfully than any other suggested, those areas which remain the domain of the robber chiefs. The two worst of these regions are the Rio de Oro hinterland and the Tripolitan

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marches; both being under foreign control, France can do no more than piously hope that Spain and Italy will put their colonial houses in order as soon as possible. But the Sabattier route lies over five hundred miles from either district. The nearest danger area is the Tafilalet in south-west Morocco; but France is confident in her ability to tame the bandit tribes of this region in ample time. Over the Central Sahara, order is maintained quite effectively by military camel companies. And in the end, this railway, like every other built in wild countries, will be its own agent of pacification. It is well known how quickly savage tribes are softened by the regular passage of the iron horse. Indeed, they often provide the labour for further construction, and then spend a part of their earnings on cheap week-end excursions.

Engineering Problems.

Few major works are called for on this route. Between Ras-el-Ma and Kenadsa advantage can be taken of the break between the Grand Atlas of Morocco and the Saharan Atlas of Algeria to cross the rugged backbone of North Africa. A long viaduct would seem necessary to take the line across the Guir valley. The next and only other important bridge will be that of Tosaye. The most serious obstacle is the waterless Sahara itself, with its moving sands. But the ergs and their shifting dunes can be avoided; and that mere sand can prevent the coming and going of trains has been disproved in a dozen places, in Arizona, in Sinai, in Australia and, in fact, in this very colony of Algeria, between Biskra and Tougourt. For the rest, the desert is "reg"—level plains of sand and gravel so compact that a camel's foot only makes a light imprint—or "hammada"—plateaux, level enough, but covered with limestone boulders. In either type of country the track can be laid almost directly on the ground, the earthwork necessary will be a minimum. Maintenance of way will call for special organization; it will be impossible to keep tiny gangs stationed at four or five-mile intervals along the whole length of the road. Gangs will have to be stronger and concentrated at water points, going out to work daily in motor trolleys. It is unlikely that this would be more expensive than the use of camel or motor transport for these parties. It is hoped that deep-bored wells will be able to supply these water points, as water tank trains would add considerably to the operating costs.

The water problem is so serious as to require a bold and original solution. Nearly seven hundred miles of bone-dry desert lie between Adrar and the Timetrin; north of Adrar the waters of the Souara and the Touat oases should suffice up to Igli; from Igli to Oran there is ample water, from the Timetrin district southwards no difficulties are anticipated. The steam locomotive is a thirsty machine, and over a distance of seven hundred miles will evaporate not less than

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160 tons of water; it is clearly impracticable to take such a quantity with the train. A pipe-line worked well enough in Sinai, but here the distance is much greater and the terminal supply conditions different; in times of peace, consideration of cost is decisive. Electric traction is peculiarly open to attack and, further, is only economical where water-power abounds or when traffic is both fast and heavy. The condensing turbine locomotive has been suggested as one way out of the difficulty, but the best hope lies in the Semi-Diesel locomotive; its water consumption is negligible, it requires only a fifth of the weight of fuel per horse-power hour necessary to the steam locomotive, and it is a far hardier prime-mover than the petrol motor. Best of all, if present hopes are realized, it will run on the vegetable oil which the Niger region can and does produce in abundance. Then, indeed, will the humble peanut come into its own.

COST AND FINANCES.

The cost is estimated at £12,000 per mile, or a total of £22,000,000. With interest at 8% to allow for amortization, the annual amount to be found by the State will be about £1,750,000 less profit made. This profit is very difficult to estimate, but one authority maintains that it may be expected to grow from nothing during the first year of operations to £750,000 in the tenth year. Account must be taken, in considering the finances of the project, of the indirect return which may be anticipated and of which the State can take monetary advantage. French administration and railway building have, in Morocco, taken the value of land up from a few shillings an acre to something between one and two pounds sterling an acre. In the Niger region, the area of land, now unsaleable but of similar potential value, amounts to not less than a hundred million acres. The State will have a just claim to a share of the enrichment to be expected. A concession for the construction and operation of the line will probably be given to the P.L.M. Company, the capital being raised by public subscription. The Government may be disposed to help with some part of the Reparations deliveries-in-kind, which it receives under the Dawes Plan.

COMMERCIAL POSSIBILITIES.

There are two main obstacles to the successful exploitation of A.O.F.; one is the climate and the other the innate laziness of the native. The white man may curse both, but can scarcely, in reason, blame either. The effects of the first are being, to some extent, ameliorated; suitable education and time may overcome the latter. Indeed it has already been noticed that the native is becoming susceptible to the lure of wages, and one tribe in particular, to the number of a quarter-of-a-million, makes an annual visit to the Gold Coast, where they work on the plantations, and whence they bring back the much-prized kola nut as the reward of their labours. The French hope

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that a remedy may be found in planting the kola in their own territory, in land grants and in making communications easier between the Upper Volta and the rest of A.O.F. than between the former and the British colonies. They hope, too, to increase the population by reducing the high rate of infant mortality (60%) and by fighting, with every weapon of medicine and hygiene, the armies of disease. Further, the railway may bring with it a new immigration of Berbers from the north, a race of many qualities. Lastly, machinery may, even here, take the place of some sorts of manual labour, and so reduce the apparent shortage.

That the country is not poor and may become exceedingly rich is admitted by all. The total value of exports in 1926 amounted to £12,000,000. At present, the country takes a great part of its wealth from the production of vegetable oil and from the head of live stock which is estimated at seven millions. Other products are cotton, sisal, hemp, kapok, indigo, rubber, gum, tobacco, manioc, millet and timber. Many districts are suitable for maize, rice and even wheat. To get the best out of the soil, irrigation works will be necessary, but these need not be on the titanic scale of the Nile barrages; for instance, the Niger almost dams itself at the Tosaye defile. But the railway must come first; once it has come, it can be assured of steadily growing reward; a reward sufficiently encouraging, it is hoped, to justify the construction of the great Congo extension. The pessimists may contend that the sea route will continue to take all the traffic. This is unlikely; in the dry season, river navigation is slow and uncertain, at all seasons the harbours of St. Louis, Dakar, Konakry, Bingerville and Kotonou are expensive in operation owing to bars. They lack natural facilities. And it is as far from Tosaye to Dakar as it is to Oran, which is less than two days' sail from Marseilles as against Dakar's ten. One estimate puts the saving in cost from Tosaye (*via* the Trans-Saharan as against the Dakar route) as high as £1 a ton. The two ways should not, in general, compete with, but should complement each other.

Passenger traffic is expected to be profitable and large. The travel habit has spread far since the War, and Dark Africa is coming into the fields of activity of Thomas Cook. The Trans-Saharan connected to the Nigerian Railways will provide a fair imitation of an Overland route to the Cape, and connected to the Senegal line should attract a good proportion of the passengers between Europe and South America. To sum up the financial aspects, one may say that here is a work of national defence that ultimately will, like no other, pay for itself in times of peace.

Comparison with some other Trunk Lines.

It may be of interest to compare this railway with some of the other great lines that have been pushed out across continents. The most

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obvious of such is the Canadian Pacific, but it is perhaps the least like ; it certainly has joined two oceans, but then, almost immediately the similarity ends. It was in no sense military—though it did secure for us British Columbia ; it took its way through what was admittedly a white man's country ; if anything, cold was the enemy, not heat ; instead of deserts it crossed mountains, and having crossed them found no railways already stretching out from the coast to meet it. It has been a success and has made a nation. The South Australian Railway does cross a desert to link up two existing systems, and has helped to give added political unity to what geography has made one ; also it does compete—and that fairly successfully—with a sea route. It was not built at the behest of a general staff. It gives an encouraging example to the builders of the Trans-Saharan. The Siberian Railway is in its objects—or at least was—the most similar to the Trans-Saharan. Russia built it to carry troops as much as to open up a new country ; it has scarcely had a fair chance and it can in no sense be taken as a guide. Looking at the Trans-Caspian, the French are heartened when they see how this line, even under Russian mismanagement, has been the means of creating a great cotton-growing industry in Ferghana, thousands of miles from anywhere. At present, France has to buy 300,000 tons of cotton a year abroad, producing in her own colonies only 10,000 tons ; she intends to make serious efforts in A.O.F. to reverse these figures.

As the world grows older, clearer and clearer does it become that every nation has need of every other nation, that none can prosper by his neighbour's troubles, that the disaster of one is the disaster of all in their varying degrees. At the same time, it were foolish to expect all nations in all their variety to act up to the implications of this axiom at once. Great ideas may move surely, but they move exceeding slow. In the interval, it behoves every people to look to its own security ; what way less offensive than that of striving to become as self-contained, as united as possible ? The peoples of Europe look across the ocean and see a young people, "an eagle mewing her mighty youth, and kindling her undazzled eyes at the full mid-day beam." They look more closely and they see this people, rich and strong, holding land that seems to contain every need except one, a land that is crossed and crossed again by more miles of railway than all Europe can boast, a land that seems less likely to be ravaged by war than any other in the world. The moral is patent. It is to achieve some semblance of American compactness that France will build the Trans-Saharan Railway, to avoid paying a heavy tribute to foreign nations that she will develop to the utmost French Africa. France hopes that this great Railway will prove an instrument of peace and an agent of civilization ; of the civilization of which she is so proud as being the oldest in Europe and not the least active.

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LIFE ON THE FRONTIER.

By CAPT. R. E. WOOD, R.E.

PERHAPS a short account of a frontier station at the moment might be of interest to those expecting to go to India in the near future. The writer has spent the last 15 months with a Sapper and Miner Company in Razmak, one of our newest outposts, and although conditions there are better than in some other stations, life is much the same on the whole.

To begin with climate, as is usual when discussing India, Razmak has the advantage of a moderate summer temperature, and real cold weather in the winter. The latter may not be considered an advantage, but it is at least healthy. In the summer, the thermometer rarely reaches 90°, nights are always cool, and a breeze usually springs up at mid-day. January and February bring snow, a foot or so, but seldom lying for more than a few days. From December till March there is frost nightly, reaching last year a maximum (or should I say minimum) of 16°.

Quarters are stone huts with corrugated iron roofs, with " pukkha " doors and windows, concrete floors, fireplaces, bathroom, and verandah, cool in the summer, but uncommonly draughty in the winter. Service conditions prevail, with such concessions as free rations for British officers, special messing allowance for the men, and separation allowance for married officers. The nearest female is at Bannu, over 70 miles away, so Razmak is an ideal place for the strong silent man. This cold weather, a camp has been established at Bannu for the families of officers at Razmak and on the L. of C., and " week-ending" has begun. There is considerable motor transport, both civil and military, and a return passage on the mail, for instance, only costs Rs. 10.

Soldiering occupies quite a lot of one's time. Three times a year or so the Razmak column, a mixed brigade of all arms, goes on tour for a week or two. These have been comparatively peaceful of late, but, of course, all military precautions have to be taken at all times. The lot of the Sappers is chiefly the inevitable water-supply, which in the majority of camps is taken direct from the nearest stream. Five thousand men and 1,600 animals, after a hot march, drink incredible quantities of water. Animals can occasionally be allowed in the

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stream, but frequently troughs, which we carry for the brigade, have to be erected owing to the bed being muddy or the supply limited. With apologies to the author of the *Manual of Field Works* (*All Arms*) I will quote some of our records. On one march the mules on arrival in camp averaged over six gallons each—not surprising, as for many of them it was their first drink of the day. It is usually impossible to water all animals before the march begins, and the poor old frontier mule must hate columns. Another day, the brigade, only 4,000 strong, took 16,000 gallons from the drinking-water point in five hours! It must be remembered that everything has to shut down, and all men and tanks, etc., must be inside the perimeter before dark. Other jobs which occasionally arise are the roping of fords, when rivers are in spate, and improvements to roads. These latter obviously cannot be extensive, but a corner where A.T. carts have to reverse demands attention. Camp approaches and assistance to the infantry in the construction of the perimeter defences are normally the task of the pioneer battalion, which forms part of the brigade.

Next to work, I am sure the most interesting subject is recreation. We cater for most games in Razmak. Hockey, soccer, and squash are in full swing all the year round. Grounds for the two former are highly dangerous at present, but a new pattern, of sifted and rammed earth, involving considerable time and labour, was proving a success when I left. The problem, of course, is to get rid of the stone menace. Four squash courts are " pukkha " concrete affairs. In the summer, there are cricket, tennis and polo. A concrete cricket pitch has been made, but the outfield is best described as sporting. A ball with an eye for country starts towards third man and finishes by blacking mid-on's eye. Tennis is conducted on normal lines. Polo takes place on what is known as the aeroplane landing-ground, as occasionally an unfortunate 'plane has had to land there. The ground has a transverse slope of about 1 in 20, and is full of delightful surprises. There is also a 9-hole golf course. As the stones grow (or seem to) like daisies, a local rule allows the ball to be " placed " for each stroke. Artificial hazards have been found unnecessary so far, and golfers with clubs they value try to borrow someone else's.

The country is unsuitable for riding, and a valuable pony undesirable. There is gradually forming a type of horse best described as a " frontier charger." Small-game shooting is run by the Brigade, areas being allotted to syndicates of 8 to 10 guns, but birds are not too plentiful. The Gurkhas specialize in bringing down pig with a ·303 in. rifle. In the summer, climbing expeditions are very popular, mountains of over 10,000 feet being only a few miles away. Officers are granted three months' privilege leave annually in Waziristan, which brings Himalayan shooting within easy reach. Kashmir can be reached in two days.

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Razmak, 6,500 feet above sea-level, with its moderate climate, allows training to be carried out under ideal conditions, and normal English hours are observed. Sapper and Miner units are chiefly concerned with operations, but in Waziristan work in close touch with the M.E.S., and a good deal of valuable experience in heavy bridging, road-work, and similar jobs is obtained. M.E.S. officers also get direct acquaintance with the organization and capabilities of the S. and M. units they may be posted to in war. A glance at the *Quarterly List* will show that a large number of junior Sapper officers are employed in Waziristan, and there is no doubt that, with the large programme of road construction now under way, service there should be attractive for many years to come.

It will be as well to mention one or two other stations not so favourably situated as Razmak, otherwise an unfortunate fellow in Manzai, for instance, may speak reproachfully. Dera Ismail Khan (D.I.K. as it is affectionately known) and Bannu, though disgustingly hot in the summer, are at least civilized cantonments, with little of the barbed-wire atmosphere. Manzai has not even this recommendation, but, as its Brigade is due to move to Wana shortly, it will cease to be a Sapper station. Jandola and Sorarogha, in the Takki Zam valley, and Miranshah, in the Tochi, are Scouts' posts, renowned for their hospitality, as the touring Sapper officer will soon find. Officers are encouraged to see as much of Waziristan as they can, and those stations in the more unpleasant places usually take advantage of free transport to visit Razmak in the hot weather. The scenery in many places is very picturesque, especially in the upper stretches of the Takki Zam valley, and has afforded the writer some quite artistic photographs. Former battle-grounds, like the Ahnai Tangi, Palosina or Makin, are of interest to the student of frontier warfare.

The circular road from Bannu *via* Razmak to Dera Ismail Khan is open for traffic from sunrise to sunset without escort, protection being afforded by local " Khassadars," a sort of irregular police, on whom considerable reliance can now be placed. It is hoped to extend our control by establishing a garrison and movable column at Wana in the next few months, and this should go a long way to the pacification and civilization of the country.

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THE NEW HARBOUR AT TANGIER.

By LIEUT. G. V. MICKLAM, R.E.

INTRODUCTORY.

THE following notes on the new harbour works at Tangier do not claim to be complete. Circumstances limited the period of inspection to half a day, and consequently much information of interest to engineers has been omitted. Further, it is only the officer with experience of harbour work who can discriminate between normal and abnormal practice in new construction.

It is, however, unlikely that such officers will have the opportunity of inspecting progress at Tangier, and therefore these plans and notes may not be out of place.

PRESENT CONDITIONS.

The strategical importance of Tangier is a subject of frequent debate in Naval and Military journals, and calls for no further comment.

Tangier Bay is silted, and ocean-going vessels anchor a mile from the existing landing stage (marked B in the Plan). Passengers and merchandise are transferred to motor boats or lighters. A low tide in conjunction with a rough sea outside the mole (marked A in the Plan) often entails another transfer into still smaller craft. The inconvenience of night landing, or embarkation, with the clamorous assistance of excited Moorish boatmen, has to be experienced to be fully appreciated. In very bad weather the Port is officially closed, and the ships pass by to their next point of call.

When the new Tangier Zone Administration was established, it realized that early action was necessary in this connection if the port were ever to develop. Tenders were therefore invited for the construction of a new harbour. The contract was given to a French firm, and the work was set in progress in 1924. It is hoped that it will be completed in 1930.

ORIGINAL SCHEME.

Plate I gives a general plan of the port, as originally designed, with the exception of the curve which now replaces the angle at the point K. The existing mole and landing stages are shown at A and B respectively. New work under the present contract is shown in

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solid black. Proposed ultimate extensions are in disconnected lines. These will not be undertaken until the financial position of Tangier is such as to justify the added expenditure. The figures in circles refer to the sections, with corresponding numbers, in *Plates 2 et seq.*

For reasons which are set out later, it is hard to foretell accurately the final area of the enclosed harbour, but it can be safely estimated at between 150 and 200 acres.

Details of the South-East Mole, and of the quay −4m, were not available at the time of writing.

It would appear curious that the outermost dredged area should be marked down to −9m, when the sounding lines indicate depths of −10m, but as this is shown on the contractor's plan it is retained in the *Plate.* Further examples of inaccuracy in paper work are quoted in a later paragraph. It will be noticed that the 4m, 6m, and 7m depth lines have been omitted, presumably for clearness.

Classification of Stone.

The stone used at the various points of the cross-sections is grouped as follows :—

Class 1. Blocks of 50 to 1,000 kilogrammes each.
Class 2. Blocks of 1,000 to 3,000 kilogrammes each.
Class 3. Blocks of 3,000 to 10,000 kilogrammes each.
Class 4 (special). Above 10,000 kilogrammes each.

Photographs.

Fig. 1 represents a very early stage in the work. Figs. 2, 3 and 4 were taken in September, 1927, and correspond to progress shown on the Plan. Fig. 5 is a photograph of the power house, near the quarries, which are shown in Fig. 6.

Notes on the Contract.

The contract is divided into two sections :—

A. *Infrastructure.* This includes :—

1. A breakwater 960 m. long, of which the shore section is 560 m. long, and the outer section 400 m.
2. An arm, known as the " Intermediate Traverse," 300 m. long, extending South-West from a point 100 m. from the further end of the breakwater.
3. A yard for coal and fuel oils, 60 hectares in area, in the angle between the breakwater and the existing mole, bounded on the South-East side by a 6-metre quay wall, (between levels −2m and +4·00 m.) for 170 metres, and on the North-East by a masonry embankment.

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4. A protective mole 150 m. long, known as the North-West Mole.
5. A quay 100 m. long, with a 5-metre vertical face between levels −4·00 m. and +4·00 m.
6. A quay of four lengths, totalling 305 m., with a 6-metre wall between levels −2·00 m and +4·00 m.
7. A quay 100 m. long, with an 8-metre vertical wall between levels −4·00 m. and +4·00 m.
8. A mole, known as the South-East Mole, with an elbow, in continuation of the above, of total length 180 m.
9. Within the coastal basin, limited by the existing works and by the works proposed above—
   A. A dredged area 3·5 m. deep, of mean width 150m., the whole length of the quay at −4·00 m.
   B. A dredged area 2 m. deep, west of the preceding, and of mean width 100 m.
10. Outside the coastal basin, and within the outer harbour, dredging and blasting, up to a total cost of 1,000,000 francs. These operations to be carried out in such a way as to form—
   A. An anchorage of about 14 hectares, 8 m. deep at low tide, and 200 m. wide.
   B. A channel of access to the anchorage, 9 m. deep at low tide, and 200 m. wide.
11. Filling, estimated at 410,000 cubic metres, of which 240,000 cubic metres are for the coal and fuel oil depôt, and 170,000 for the quays and their connections.
12. Protective masonry for the quay platforms and communications.
13. 4,000 square metres of paving, and 10,000 square metres of metalling.
14. The drainage scheme of the town.
15. Water and electricity mains for the harbour works.
16. The fencing of the harbour area.
17. Port lights and buoyage.

B. *Superstructure.* The following are included in the finished programme of the work :—

1. A warehouse 50 × 20 metres, consisting of a steel framework filled in with brick, with a tiled roof, and equipped with Decauville track and hoisting and travelling gear.
2. An open shed 50 × 20 metres, in wood or corrugated iron.
3. Two cranes, one 3-ton, and one 5-ton.
4. A 20-ton derrick crane.
5. 450 metres of track for cranes.
6. A 250 H.P. winch.
7. A motor water barge.

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8. Administrative offices for harbour authorities, including, on the ground floor, two rooms for the *Service de Contrôle*, two rooms for the Harbourmaster, and one for the Pilot Administration.

9. A permanent building to include—

Passenger waiting-room.
Sanitary services.
Postal and Telegraph Offices.

10. The contractor will erect a disinfecting station at the expense of the Tangier Zone Administration, on a site chosen by it.

Note.—Railway Tracks.—The track for harbour communications and developments, with the exception of crane track, will be laid by the *Compagnie Concessionnaire du Chemin de Fer de Tanger à Fez*, at its own expense, in compliance with the existing regulations of that Company.

Labour.

Labour is cheap and plentiful. A mason is paid 10d. a day, and an ordinary unskilled labourer 3d., in present-day equivalents.

Power for Quarries.

Two 80 H.P. National gas-engines are used, one driving an air compressor, and the other a D.C. dynamo for lighting. The generators, scrubbers, and receivers are housed in one end of the main building, adjoining a large sliding-door giving access to the open air (*see* Fig. 5). No stand-by plant is provided, and it is therefore presumably considered unnecessary. The compressed air is transmitted to the tools in the quarry through a 3-inch pipe line. This is made up of 5-metre lengths of steel piping with flexible joints. The line lies out in the open on unprepared ground beside the light railway, and is capable of taking steep curves satisfactorily. Fig. 5 shows the pipe line to the right of the right-hand track. To the left and beyond the power-house can be seen the electric overhead monorail sand hoist overhanging the beach, which lies to the left of the picture. The control cabin is hidden by the gable.

Repairs.

There is a large workshop, sparsely equipped, near the starting point of the new work. It is chiefly employed on repairs to locomotives, rolling stock, and cranes.

Methods.

The stone is blasted from the cliffs which line the coast to the west. It is brought some four kilometres along the water's edge by light

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railway. Some is required to form the aggregate for the 35-ton blocks which are made up near the site. The stone passes through crushers to a steam-driven mixing plant. Other stone is dropped where required to form the breakwaters, etc., and is there packed by natives with crowbars, assisted by the small steam-cranes.

The concrete blocks are left out in the open for three months before use. They are placed in position by the "Titan" crane shown in Fig. 1, at the head of the work. The photograph also shows four rows of blocks waiting their turn for use, and three of the small cranes employed on lighter work. Fig. 4 shows two of the blocks, each approximately 2 × 2 × 3 metres, in position. The two slinging grooves on each side of a block can be distinctly seen.

REMARKS.

There are one or two points about the harbour scheme that call for comment. The first is that, although the work is now in a fairly advanced stage, the plan and sections are still under discussion, with a view to alterations in design. The curve was substituted for the angle at the point K when work on that part of the breakwater was imminent. Again, Section 5 has just been completely redesigned, with a considerable increase of cross-sectional area. Altogether there is a vagueness and lack of finality about the scheme, which may, or may not, lead to improvement on the original project as submitted to the Tangier public works engineers for approval.

A second point is that the provisions of the agreement allow for payment to the contractors at monthly intervals, such payment being based on the amount of mole that has been completed to full section. This means that the work is growing outwards from the shore, instead of upwards from the sea bottom. No sooner is a short length of foundation dumped, than the blocks are laid in position, and the filling is hastily completed up to the level of the finished work. Very little time is allowed for the inevitable settlement of the rubble and hand-packed blocks. It may, however, have been impracticable to organize the work otherwise.

The third point is, on the face of it, trivial, but it is understood that much trouble and waste of time was caused by it. In bills of quantities, estimates, etc., the decimal point was represented by an ordinary comma. As the figures used exceeded a million in most cases, it was found that it was not easy to differentiate between the commas separating the thousands digits, and the decimal points. It is said that the French engineers themselves were led into errors in this manner; errors which were only discovered when the engineer of the Tangier Zone checked the figures. This is a striking example of the necessity for the most minute and careful scrutiny of all Tables of figures which have been typed out from a correct manuscript.

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THE NEW HARBOUR AT TANGIER.

Fig. 1.

Fig. 2

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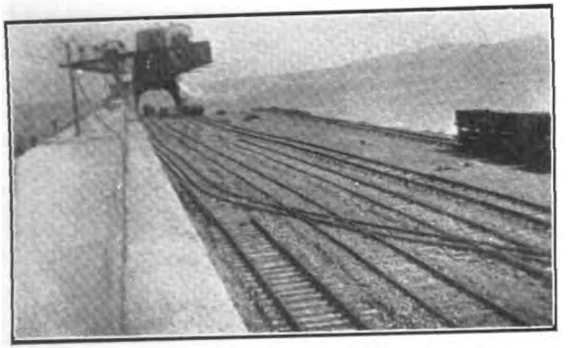

FIG. 3.

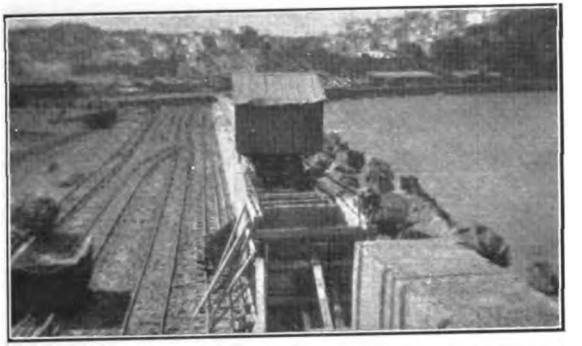

FIG. 4.

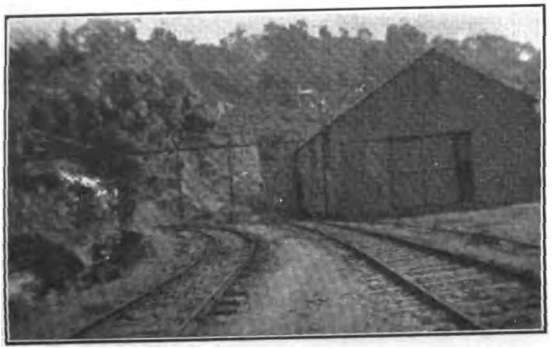

FIG. 5.

FIG. 6.

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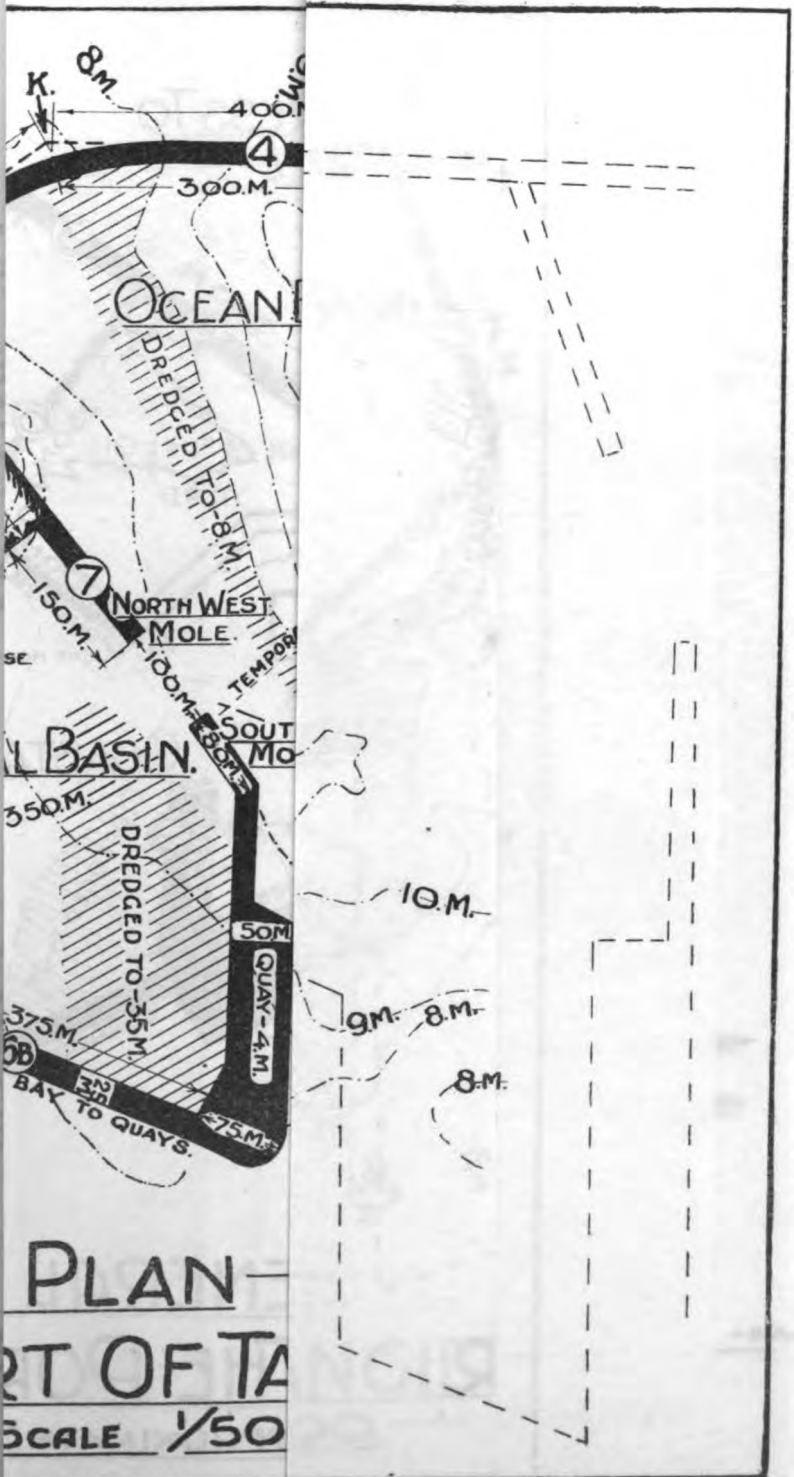

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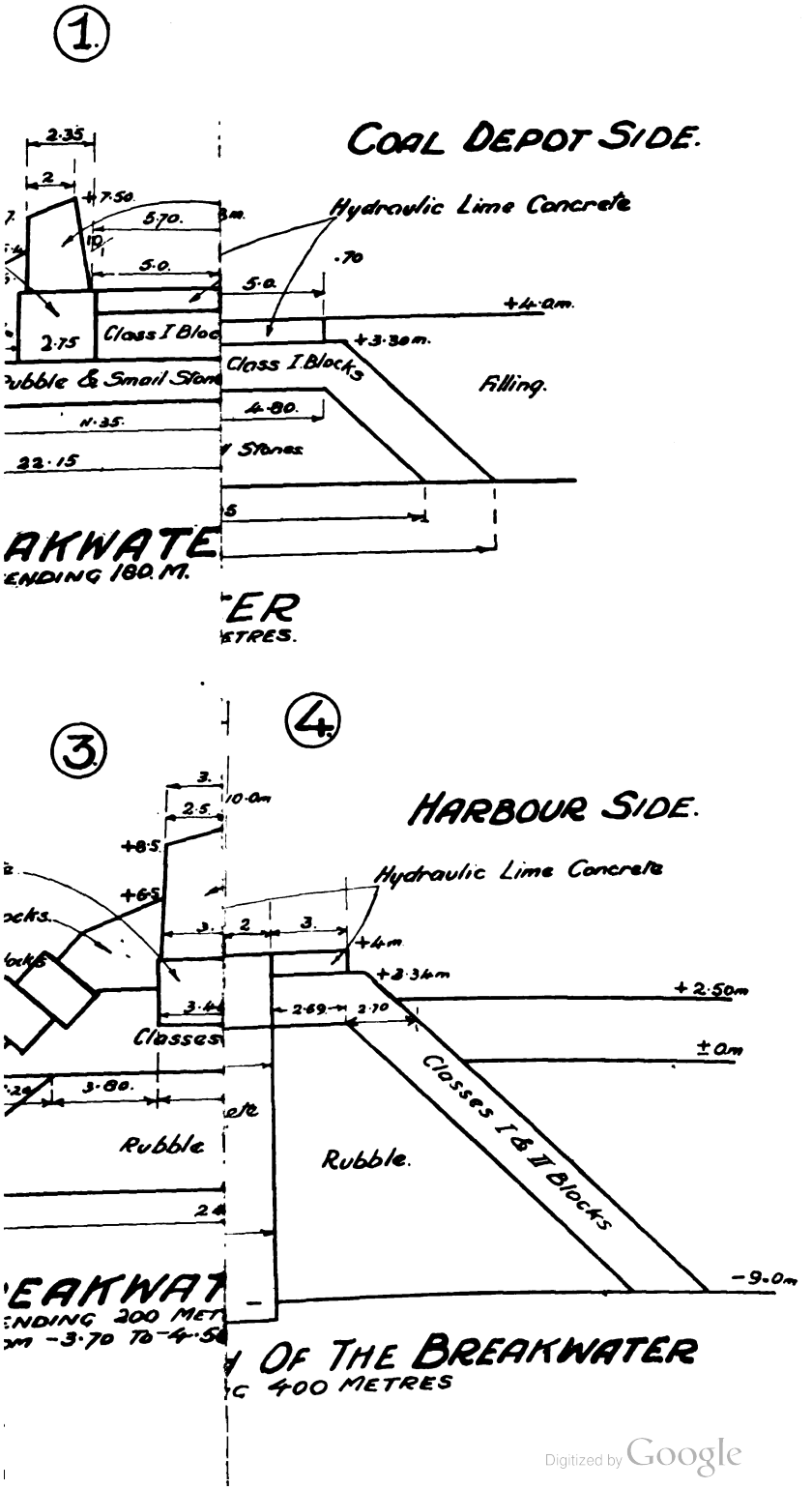

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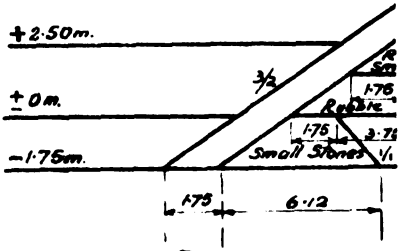
SEA SIDE.



PROTECTI
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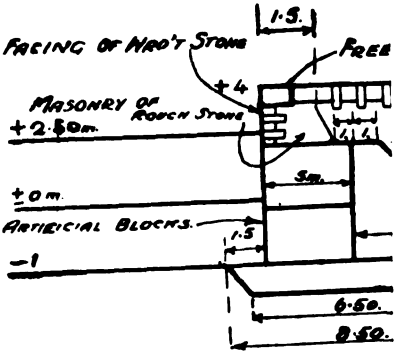
For Quays Between -1 & -2, And
These Quays To The Quay At -4



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TRANSPORTATION, AND THE LAY-OUT OF AN OVERSEAS BASE.

A Lecture delivered to the Officers of the Garrison at Bombay on August 10th, 1927, by BT. LIEUT.-COLONEL W. G. TYRRELL, D.S.O., R.E

I.—GENERAL CONSIDERATIONS.

UNDER the present organization of the Army for War, the Director of Transportation deals with Ports, Railways and Inland Water Transport. This involves the construction of new work and the maintenance and operation of both new and existing work. In order to ensure success in War, one of the essential factors is that the fighting troops should be provided with a sufficient quantity of stores of all sorts, at the right place and at the right time. The Transportation service is largely concerned in this, particularly if the line of communication is long.

The Transportation service undertakes the movement of men, animals and materials. Whether units and formations will be moved up to the front by rail will depend on distance, urgency, commitments as to movements of stores and the total capacity of the railways. In any case, the railways never undertake their movement through the whole of the base area. Troops after disembarking will proceed by road to the rest and reinforcement camps, which should be situated outside the seaport town. A station within a few miles of the camp can usually be set apart as a troop entraining station. As this station will not be required for other purposes, every facility can be provided to ensure comfortable and rapid entertainment of all classes of troops. The *Field Service Pocket Book* gives the number of trains required for the higher formations as 78 for an Infantry Division, and 69 for a Cavalry Division. Each of these, roughly, demands three days' full capacity of a single line, and a whole day's capacity of a double line, the best conditions being assumed in each case. It will thus be seen that the movement of troops by rail will make serious inroads on the capacity of the railways.

Stores *must* be moved by rail, and it is of primary importance to know the total requirements of any force. The requirements of the two principal higher formations are shown in Table I.

The lower figures for Ammunition and R.E. Stores are for a war of movement, while the higher ones are for stationary or trench warfare.

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The total requirements of the whole force can be based on the number of Infantry Divisions, if a proper allowance is made for other formations. The allowances to be made are :—

For Corps Troops	25%
For G.H.Q. Army and L. of C. Troops (includes Cavalry Division)	20%

We will not be far wrong if we add 50% to the requirements of the Infantry Divisions.

TABLE I. DAILY REQUIREMENTS IN TONS.

Commodity.	*Infantry Division.*	*Cavalry Division.*
Supplies and Forage	100	132
Petrol and Oil	6	3
Coal and Other Fuel	26	14
General Ordnance Stores	45	25
Ammunition	50—80	30—60
R.E. Stores	40—80	15—30
Mails, M.F.O. and Canteen Stores ..	8	5
	275—345	224—269

In addition to the daily requirements of the force, a considerable reserve must be maintained in order to guard against interruption of communications and fluctuation in demand. The amount of the reserve to be maintained may vary with the distance of the overseas base from home. It need never exceed 30 days' requirements, and should never be less than 15 days' requirements. When the reserve is less than 30 days, the balance to make up the 30 days' reserve should be immediately available within a short distance of the shipping port at home. In effect, this means that a 30 days' reserve is always maintained within a reasonable distance of the overseas base.

2.—THE PORT.

No arrangements for dealing with stores at a port can be made unless we have some idea of the quantities which will arrive in each ship.

These figures are of considerable importance, as such things as depth of entrance channel, depth of harbour, and amount of manœuv-

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ring space may limit the size of ship which can be received. The programme for dealing with ships will be considerably affected by the rise and fall of the tide, as some ships may be able to come in at any time, while others must wait for high water.

TABLE II. DETAILS OF SIZES AND LOADS.

Length, feet.	*Loaded draft, feet.*	*Average tons of Army Stores.*
200	15	800
300	20	2,400
400	25	4,800
500	30	8,000
600	35	12,000

The rate at which ships can be unloaded bears a simple ratio to the length of quay which they occupy. The rate of unloading is considerably affected by the mechanical equipment, *i.e.*, power cranes, on the quay front. Quays are considered to be well-equipped if there is, on the average, one crane for each 90 ft. of quay frontage. In well-equipped ports, the average rate of unloading of all classes of stores is about one ton per foot of quay front per shift (a shift is taken as eight hours). Where there is no mechanical equipment on shore and only the ship's winches are available, a rate of half-ton per shift is all that can be expected. For calculating unloading rates, the length of quay occupied by a ship can be taken as the ship's length plus 75 feet. Owing to losses which must occur, due to succeeding ships being of different lengths and to the space required for mooring-cables, a length of 150 feet should be added to the ship's length for each berth occupied. So, in order to find the number of berths which will normally be occupied, divide the total quay frontage by the average length of ship plus 150 feet. Then the number of berths multiplied by the average length of ship, plus 75 feet, and again multiplied by the unloading rate, will give the unloading capacity in tons.

The possibility of constructing additional quays without interfering with the free use of the port should be examined in detail. Where increased facilities are required, new construction work should be undertaken. New quays of a temporary nature will require at least one ton of material per foot run of quay, and a rate of construction in excess of 1,000 feet per month should not be counted on, unless a very large construction force is available. We can then forecast the maximum capacity of the fully developed port, and the date on which it will be available.

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All materials which are unloaded from ships should be removed immediately by rail to the various depots established to receive them. The retention of stores in the docks will eventually lead to congestion and reduced output. An apparent exception to this rule is when the existing dock facilities are in excess of what is required by the force to be maintained during the period when the main depots are being constructed. The storage space opposite such excess quay frontage can be conveniently used for temporary depots, if adequate road access is available. In order to avoid delay in the unloading of ships, loaded wagons should be removed promptly and a plentiful supply of empties should be available. An ordinary 10-ton wagon will contain an average load of seven tons when carefully loaded at a depot for shipment to the front. With the more rapid and less careful loading necessary to prevent delays to ships, it is improbable that an average load in excess of five tons will be obtained. As such a wagon will account for about 25 feet of quay frontage, it will be necessary to change the wagons five times during each eight-hour shift. This entails considerable railway activity.

For the discharge of ordinary cargo, cranes of 3-tons capacity have been found to be the most suitable. Cranes up to 10 tons capacity will be required for lorries and guns, and up to 30-tons capacity for tanks, while lifting equipment with a capacity up to 100 tons may be required for locomotives.

Before finally deciding what port capacity is available for the maintenance of the army, adequate provision should be made for the needs of the civil population. It is difficult to lay down any rules for this, as conditions are so variable. Exports and imports are likely to be less than in peace time. Fifteen per cent. of the capacity of the fully developed port is suggested as a minimum figure

3.—DEPOTS.

Stores depots may be classed as Major and Minor, as follows:—

The figures in brackets under the major items represent storage capacity in tons per acre, including spaces and gangways required in connection with the working of the depot, except in the case of item (*c*), which is based on gross area. Total tonnage divided by these figures will give net stacking space.

Major Store Depots:—(*a*) Supplies, forage, petrol, oil and fuel for troops (2,800). (*b*) General Ordnance Stores (1,100). (*c*) Ammunition (30–45). (*d*) R.E. Stores (1,000). (*e*) Transportation Stores (1,500). (*f*) Coal (2,000).

Minor Store Depots:—(*g*) Mails. (*h*) M.F.O. Consignments. (*i*) Canteen Stores. (*j*) M.T. Stores. (*k*) Medical Stores. (*l*) Veterinary Stores.

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Ordnance workshops will always be adjacent to the general Ordnance Depot. Allow the same space as for general Ordnance Stores.

In addition to these areas, space will be required for railway sidings for loading and unloading, sidings to facilitate the operation of the depot and connecting lines. To take in all these railway lines, a gross area of four times the net area will be required in the case of depots (*b*), (*d*) and (*e*). On account of the highly inflammable nature of some of the stores, the gross area for depot (*a*) is eight times the net area. The figure for depot (*c*) is based on gross area, so that no multiplication is necessary. The gross area of depot (*f*) is twice the net area. No figures are given for depots (*g*) to (*l*), as the total quantities are quite small, and considerations of situation are usually more important than area. Whatever area is found to be necessary for each depot, one should not lose sight of the fact that future expansion will probably be required.

The siting of the various depots is usually a cause of controversy between the various departments concerned. In the first place, the General Staff will probably lay down two principles to be followed which are mutually antagonistic (these two principles have always been laid down at any exercise on this subject attended by the lecturer). They are :—

(*a*) The sites of the depots must be sufficiently dispersed to considerably reduce the risk attendant on aerial attack.

(*b*) The depots and the base regulating station must be sufficiently concentrated to facilitate anti-aircraft defence.

This question will usually be settled by the topography of the locality.

A tendency always exists in some quarters to earmark th best piece of level and unobstructed ground as an aerodrome. This is quite wrong for reasons that will soon become apparent.

Aeroplanes can quite easily and safely take off from and land on gently undulating ground, and it is no detriment if a sufficient area of such ground is situated on the top of a hill. For use as depots served by railways, such ground would be useless on account of its configuration and its situation. Ground for the major depots, except that for ammunition, should be of uniform slope (or easily made so). The slope in the direction of loading and of unloading sidings should not exceed 1/250, as this is the steepest slope on which an unbraked wagon will cease running after having been put in motion at a low speed. The transverse slope may be greater. In the region of seaports, the greatest areas of flat ground will usually be at low elevations. The reasons for reserving such areas for railway-served depots will become readily apparent as the result of a short calculation. In the circumstances assumed, the gradient of a main-line railway should

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not exceed 1/200. The loads which could be hauled by a 60-ton shunting engine are :—

On 1/200 grade	..	..	..	..	1,020	tons.
,, 1/100 ,,	..	..	..	..	580	,,
,, 1/50 ,,	..	..	..	..	300	,,

This shows the difficulties which are to be encountered if we attempt to run railways up hills.

No attempt should be made to site the major depots (except that for coal) in or adjacent to the seaport town. The less the disturbance of the ordinary life of the town, the easier will be its control and administration by the Base Commandant. Railway operation will be greatly facilitated if the depots for supplies, general ordnance stores, R.E. stores and transportation stores are as close together as possible. Otherwise, supplies and ordnance should be near one another, as both consign goods direct to units, whereas R.E. and transportation stores are usually sent forward in bulk. Ammunition must be well removed from all other depots, and, if possible, should be served by some little-used branch railway line. Spurs for unloading can be run up small valleys with considerable addition to the safety of the lay-out. Coal, which is a comparatively fragile material, should be subjected to as few handlings as possible. For this reason, the coal depot should be in the docks, and a portion of the quay front should be set apart as a coal dock, so that the dump may be made immediately behind it.

Distance from the port is not a disadvantage, as the main consideration in siting the depots is suitable ground. As long as the stores are moving forward in the right direction, and the base regulating station is in advance of the depots, there is no loss of movement.

Minor depots may be placed in the town if suitable sites can be found. The M.T. depot and repair shop should, however, be on the outskirts, so as to allow for future expansion. This depot must have both road and rail access.

During the construction of the main depots, temporary arrangements must be made for the maintenance of the force. For this purpose, any suitable vacant pieces of ground and buildings may be taken into service. The reserves to be maintained during this period need not exceed one week's supply. Most of the ordinary rules regarding depots generally may be broken during this period, as it will be very much a time of give and take. As portions of the main depots are completed and declared ready for occupation, they may be made use of, particularly for the building-up of the necessary reserves, and the temporary depots may be gradually closed if convenient.

Considerable quantities of R.E. Stores will be required for construction of buildings, etc., in the various depots. As the amount is

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large, due regard must be given to it when allocating the total port capacity. The proportion of the net stacking space of each depot which requires covered accommodation may be taken as follows :—

Supplies, 20% ; Ordnance Stores and Workshops, 40% ; R.E. Stores, 10% ; Transportation Stores, 8%.

The weight of the materials for one acre of buildings may be taken as 300 tons.

For camps and various other items of base development, the covered area required may be taken as half an acre per division in the field.

The number of construction units and the rate of arrival of the materials required will determine the date on which the fully-developed base will be available for use. A reasonable proportion of such units will enable the work to be carried out in three or four months. Four months should be looked upon as a maximum.

4.—Railway Stores.

The calculation of the amount of railway material and stores required is an intricate business. However, a few simple rules will enable quite useful preliminary estimates to be prepared. For the construction of the depots, the calculation must be based on two factors. The lines serving the stacking spaces depend for length on the reserves maintained. For every acre of net stacking space 1,200 feet of track will be required. The main ammunition depot will require one mile of track for every 3,000 tons stored. The sorting sidings for serving the store grid must deal with the daily traffic. The track required will depend on the number of divisions served, the rate being 3½ miles of track per division. Some track will be required for development and improvement of the dock area. Coal and other railway operating stores depend for quantity on the length of line of communication. An approximate figure is 10 tons per 100 miles of railway per division in the field.

For new railway construction in the forward area assume 1/4 mile of track per day per division in the field. The weight of a mile of track with bridging material and other accessories may be taken as 360 tons.

Railway tracks will be required on any new quays which are constructed, the length required being five times the quay frontage. Some extra track will also be required for additional sidings in the dock area.

5.—Force which Port will Support.

With all the previously noted facts in our possession, we are in a position to work out the size of the force which can be maintained through the port in question. The method of producing the results can best be explained by working out an imaginary example.

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Assume a port possessing well-equipped quays with a total frontage of 8,000-feet run, with the possibility of 2,000 feet additional being provided by development. The largest ships which can be taken into the harbour have a draft of 25 feet. A few months after active operations start, the railway L. of C. is expected to be 300 miles long. Reserves of stores for 20 days will be held.

The ultimate total length of quay will be 10,000 feet, so that at 550 feet per berth there will be 18 berths. Three of these should be allotted to the civil population, leaving 15 for army use. The unloading rate for each berth will be 475 tons per shift. We will assume only one shift per day, during the development period, and two shifts per day after its completion. This is possible on account of the release of the unskilled labour from the development works. The total tonnage which can be landed from 15 berths will be 14,250 tons per day after development is completed.

The daily requirements of a division will be taken at the higher figure given in Table I.

General Stores	345	tons
50% for ancillary troops	172	,,
Railway track	90	,,
Railway operation	30	,,
	637	,,

The total force which can be maintained is therefore 22 divisions. Let us assume that development can be completed in four months, and that after 2½ months 1,000 feet of the new quays can be taken into use fully equipped. We may take it that the original 8,000 feet of quay will provide 14 berths, of which three are for civil use, and that each 1,000 of new quay will provide two berths. The number of berths available and the total unloading rates per day will then be :—

Period.	*Berths available.*	*Shifts per day.*	*Tons per day.*
1st 2½ months	11	1	5,225
Next 1½ months	13	1	6,175
After 4 months	15	2	14,250

We must now work out the areas of the various depots. This is best done in the form of a Table. Table III gives the details. From this Table we can work out the weight of stores required for development. The railway grids in the depots at 1,200 ft. per acre of net stacking space will require 178 × 1,200 feet of track, which is 38 miles. The ammunition depot at one mile per 3,000 tons stacked will require 18 miles. New quays and additional works in the dock area may be taken as seven miles. The total railway track for development is therefore 130 miles, weighing 50,400 tons.

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TABLE III.

AREAS OF DEPOTS, ETC., FOR 22 DIVISIONS AND 20 DAYS' RESERVE.

Item.	Daily requirements.		20 days' reserve for 22 divisions.	Tons per acre in depot.	Net stacking space.	Gross depot area.	Covered area.
	Per division.	Plus 50%.					
	Tons.	Tons.	Tons.		Acres.	Acres.	Acres.
Supplies	100						
Petrol and Oil	6 } 132	198	87,120	2,800	31	248	6·2
Fuel	26						
Ordnance Stores	45	67½	29,700	1,100	28	224	22·4
Ordnance Workshops ..	—	—	—	—	28 } 56		
Ammunition	80	120	52,800	45	—		
R.E. Stores	80	120	52,800	1,000	53	212	5·3
Transportation materials ..	—	90	39,600	1,500	27	108	2·2
Coal	—	30	13,200	2,000	7	14	—
Canteen Stores	6	9	3,960	1,000	4	16	—
Totals		634½ (excludes mails and M.F.O.).	279,180		178	822	36·1

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The 2,000 feet of new quays will require 2,000 tons of materials. The depots require 36·1 acres of covered area, and other development works at half acre per division will require 11 acres, a total of 47·1 acres. At 300 tons per acre the weight will be 14,130 tons.

The summary of materials for development is :—

Railway track	50,400 tons.
Quays	2,000 ,,
Other development	14,130 ,,
	66,530 ,,

Of this, one-half should arrive during the first month, and the balance during the succeeding two months, so that all the materials will be on hand by the end of the third month. This gives a daily rate of arrival of development stores of 1,110 tons per day for the first month and 555 tons per day for the next two months.

The final calculation, showing the use of the available port capacity, is also best worked out in tabular form, as shown in Table IV. There are, of course, many other ways of dividing up the daily capacity of the port between maintenance and reserves. If a larger force is required during the development period the building up of reserves will be slower, and hence the date at which the full force can be maintained will be more remote. Two shifts per day have been assumed for unloading in the docks. If enemy air action prohibits night work as a regular practice, it may be necessary to assume an average of 1½ shifts or perhaps only one, in which case the strength of the final force would be 17 and 11 divisions respectively. There would also be a corresponding reduction in the sizes of the depots and the quantities of stores required for development purposes.

It is considered that the largest force which can be maintained economically and conveniently through one port is 30 divisions.

The ideal arrangement is to maintain the covering force through a small port, which can be used as it is found, while the development of the main port and the depots is carried out elsewhere.

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TABLE IV

USE OF PORT CAPACITY.

Period.		Daily capacity, tons.	Development stores daily tons.	Balance for maintenance and reserves.		Divisions maintained	Reserves at end of period in Div. days	Reserves available for	
Months.	Days.			Tons	Divisions.			Division.	Days.
1	11	5,225	1,110	4,115	6½	4	28	4	7
	19	5,225	1,110	4,115	6½	4	74	6	12
1½	45	5,225	555	4,675	7	6	119	22	5·4
½	15	6,175	555	5,620	9	6	164	22	7·4
½	15	6,175	—	6,175	9½	6	216	22	9·8
½	15	6,175	—	6,715	9½	8	238	22	10·9
1	29	14,250	—	14,250	22	Average 15	440	22	20
After 5 months.		14,250	—	14,250	22	22	440	22	20

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THE BOMBAY ENGINEER OFFICER OF 1800.

By ARTHUR VINCENT.

[NOTE.—In this article, the old-style long "s" is printed as an "f," due to the limitations of modern type.—EDITOR.]

BY the courtesy of Lieutenant-Colonel L. F. G. S. Wylde, O.B.E., of the Military Accounts Department, I have recently enjoyed the opportunity of perusing a particularly interesting book which cannot be commonly known, and of making some extracts which may be of interest to the Corps. The title of the book occupies most of its front page; its essential part is :—" A compilation of all the Government and General, Government, General, Brigade and Garrison Orders, Minutes of Council, Commands of the Hon. Company, or regulations, from whatever authority promulgated, from the year 1750 to the 31ft of July 1801, that are now in force and operating on the Discipline or Expenditure of the BOMBAY ARMY." The compiler was Captain Edward Moor, and the publishers the " Courier and Gazette Presses " in 1801.

The book is fairly large, and is a perfect mine of information which throws light on all sorts and kinds of rules and amenities of the Service a hundred and twenty-five years and more ago, and is, at times, by no means devoid of unconscious humour. For instance, making allowance for the different outlook of somewhat coarser days, it is interesting to find in a General Order of 1770 a sentence which still holds good, though in politer and more moral terms to-day: " A foldier fhould be as attached to, and careful of, his musket, as his miftress."

To review the book even on broad lines would be impossible in a restricted space, it covers such a multitude of issues, and gives such general and accurate pictures of contemporary life and work through the medium of dry governmental detail. Only the main aspects of Sapper life will therefore be touched upon, which I have taken as military status, works, and the ever pertinent subject of pay and allowances.

In those days of yesterday, the military position of Engineer officers appears already as a matter for discussion. After all, up to a very short time ago, one occasionally met misguided A.C.R.E.s, as they were then, who allowed the temporary command of their stations to devolve on officers of other arms junior in army rank, because " they had no time to do it." The question is partially

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discussed in 1796, in respect of touring engineer officers. In those days, touring was naturally a different affair from its counterpart to-day; without trains and cars it was a slow and long business, which must have involved the presence of senior Sappers for considerable periods in stations commanded by their cavalry, artillery or infantry juniors. Such inspecting officers are tactfully warned off the ground of local administration and discipline, as also of the command which in present-day short visits they would never dream of asserting, but the officer actually named is informed that he " will alfo, if he pleafes, give out the parole and counterfign," an important recognition of status in those days. As the individual officer in question was Lieutenant-Colonel Sartorious, that family may add to its brilliant military record the useful achievement of having been very early in the field to secure their right status to the Corps officers.

In 1797, a command of John Company's, applying thus presumably to all India, goes into the question in much detail. The Engineers are to receive the full honours of their rank, whilst command and administration remains with the permanent commander, who is responsible for it at all times, a very just decision, since this part of the order relates only to Sappers on temporary or inspection duty in those days. Apparently some or others of them had tended towards interference, for we read the following paragraph, which will be snorted at duly by the hardworking infantryman of to-day, to say nothing of the cavalry and artillery, who are not deemed worthy of so much as mention :—

> " No perfon entertains a more refpectable opinion of the profeff-ional importance of the corps of engineers, than the commander in chief, but it is evident that an officer employed in repairing or conftructing works, cannot afford the requifite attention to the duties of detail and difcipline, which is undoubtedly the peculiar province of the infantry officer, whofe leisure (*sic*) and education beft qualify him to conduct this part of the fervice ; as on the other hand, an engineer is, indifputably, the fitteft judge in matters relating to his own department."

Officers and officials of more than one kind might with profit take notice of the concluding sentence of this Order, which is now one hundred and thirty-one years old !

At the same time, be it particularly noted, the same order vests the command of the station definitely in the engineer officer, if he is the senior officer permanently stationed in the garrison.

The question of command during attack by an enemy, whilst the senior officer momentarily present is an inspecting Sapper, is delicately avoided ; but it is laid down that only an attack by an enemy justifies the station commander in ordering junior inspecting Sappers on any but their own work.

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Nowadays, matters are far more cut and dried; but it is not without interest to find, as early as 1797, the implicit admission of the tenet that Sappers are soldiers first and engineers afterwards.

Next, one may pass to the subject of works.

It would seem that in 1800, officers were not automatically looked upon as being of the fibre of to-day! Upon the completion of a contract work the engineer officer, not excluding a Chief Engineer, had to sign and deposit very formally a "written affirmation upon honor, that he has not directly or indirectly had or will have any participation or concern in the providing or fale of the materials, nor derived nor will derive any benefit or emolument whatever from the work carried on under his infpection, over and above the ftated allowances affigned to him by government."

Furthermore, "The chief engineer muft be acquainted that he is to have nothing to do with the execution of public works except as an officer of controul (*sic*)"; and, "in confideration of the allowances granted to him, he is to be reftricted from having any concern whatever on public buildings or works, or in the materials ufed therein." Chief Engineers must have had a jolly junketing time before 1795, the date of these orders.

For the execution of work there was apparently a standing "Agent for buildings and repairs," to whom new works costing less than ten thousand rupees could be given without tender by Government if it saw fit. Larger works had to be done by contract, and "offered to the loweft bidder"; with a curious rule whereby on big repairs a contractor could draw two-thirds of the cost in advance. Bombay had apparently yet to meet the worthless native who submits an impossibly low tender in order to get the contract, simply as a means of raising his bazaar credit where he has no capital; and then either tries to cover his impending losses (including huge interest to money-lenders) by inferior and faked work, or, as has been known, bolts into the blue after he has squandered the borrowed money, and leaves a very nasty mess for the unfortunate engineers to sort out. We are wiser in these days, when not a penny of advance is permissible, and acceptance of the "lowest reliable tender" is a general rule.

In slightly older days, one recollects grouses at the multiplicity of periodical reports required upon works in progress, which, after all, are or ought to be as useful to the officer who makes them as they are important to his superiors. It may thus be of interest to note that the monthly progress report was apparently born officially on the 18th of December, 1796, and had to be prepared in considerable detail.

For very many years now, insistence on a proper knowledge of Indian languages has been almost a stronger tenet in the Corps than in the army as a whole. Before the war, one recollects C.R.E.s and Commandants of Sapper and Miner Corps who rightly used all

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legitimate means to prevent their young officers from resting content with the minimum statutory qualification of the old Lower Standard examination. In 1800, however, times were apparently easier, for a chief engineer's establishment paid for by government included an interpreter, at the then liberal rate of twelve rupees a month. Furthermore, it included sixty rupees, a comfortable wad of money in those days, each month for "palanquin and conveyance." Happy days! One can fairly see that interpreter perspiringly accompanying the lordly palanquin.

The important question of pay and allowances is gone into at great length. Curiously enough, with one notable exception, the emoluments of the engineer officers seem to have differed in no way from those of the other arms. The ordinary regimental tables may be of interest; emoluments were composed of pay and "batta," only half-batta being drawn in peace. The rates were as follows:—

		"In garrison."	*In the field.*
For a 30-day month :	Lieut.-Colonel	630	1,009
	Major ..	495	799
	Captain ..	296	436
	Capt.-Lieut.	266	406
	Lieutenant	168	254
	Ensign ..	129	200

They seem, of course, very small, but the relatively enormous purchasing power of the rupee in 1800 must be given full weight. Exactly how it compared with the depreciated article of to-day it is difficult to say. The writer can testify from family records that a married officer with children forty years ago had as comfortable a time as a similar family now enjoys on just four times the pay; and it may be presumed that, eighty years earlier still, money went proportionately further still.

It is curious to note the old coinage; the tables are made out in rupees, quarters, and "reas," the latter presumably a hardy survivor of the days of Portuguese rule in Bombay. The tables thus read "Rs-q-re," as compared with the Rs-a--p of to-day. It took four hundred reas to make a rupee, so that the fact of the detailed inclusion of reas in rates, even to half a reas in one case, makes one suspect that the purchasing power of money must have been high indeed. The reas was an almost universal insect, cropping up everywhere. Eighty of them, *i.e.*, one-fifth of a rupee, were solemnly tacked on to the princely salary of a chief engineer in the field, to cover what contingency this deponent knoweth not.

The exception noted to the similarity of pay between all arms was the "Colonel, chief engineer." His was eminently the post to hold. From the Rs. 630 of a Lieutenant-Colonel in garrison, his salary soared straightway to the heights of Rs. 2,340 for a 30-day month;

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and in the field he drew Rs. 2,419, to which were added eleven rupees a day "table money," and the allowance for two horses which was open to all commandants of engineers in the field, if field officers.

Of his princely pay, whether in garrison or in the field, Rs. 1,200 per month was an "Establishment in lieu of commission on public works and of all contingencies"; an amusing indication of what must have been one of the earlier attempts to give responsible but comparatively lesser military officers emoluments which would place them beyond temptation. It is not clear from the volume how much of the Rs. 1,200 was destined straightway for the Colonel's pocket, and how much might have to be disbursed on contingencies. As, however, his government-paid establishments included office rent, clerks, lights, stationary (*sic*) and other details which were all specifically legislated for outside the pay table, and it seems likely also that he got either a Company's house or house-rent, there is a strong presumption that all of the Rs. 1,200 was the equivalent of modern charge pay.

It is thus interesting to compare his Rs. 2,355 average monthly pay with that of his latter-day successor, the C.R.E. 2nd Class of the Bombay District, who gets Rs. 2,010 if a lieutenant-colonel, and Rs. 1,750 if a major, with the general purchasing power of the rupee probably at one-tenth or less of what it was in 1800. Even the Chief Engineer of the Southern Command, who is chief engineer of both the Bombay and Madras Presidencies, beats the old Colonel by a beggarly 145 cheap modern rupees!

It must be admitted that chief engineers sometimes suffered a sly dig from behind, as witness the following (24-9-1799):—

> "As the practice of allowing any defcription of officers to draw full field allowances, whofe duties are ftationary, is contrary to the original and real intention of that indulgence, which is granted with a view to enable an officer to fupport the extraordinary expences of equipment, neceffary either for a ftate of actual movement, or when the circumftances of his fituation require him to be prepared for this event. It is accordingly refolved, that when thefe circumftances do not exift, officers, fhall not in future be entitled to full field allowances; which applies to the fuperintending engineer at the prefidency, Cananore, Paulghatcherry, and Cochin."

Which rather looks as though four senior Sappers were the only poor fish in that pool.

The following General Order, dated 17th March, 1795, has quite a modern tang about it:—

> "When officers conceive they are entitled to any allowances not granted to them by the pay table or any fpecific regulation, they

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are not to bring the matter forward by an indent to the paymafter, but muft make application to government through the commanding officer of the forces, obferving the regular channel."

In other words, " Never waste your breath in arguing with a C.M.A., who has no discretion with the rules of his Department ; but put the case up straightway to your commanding officer, for consideration through the channels of military command "—one of the golden rules of a quiet life in India, which applies equally to all questions of your own and of government finance.

A couple of other rules of detail, common to all arms, are worthy of note. Just as laid down in our Post Office notices of to-day, any officer or other rank who suspected a bad coin in his pay, could have it examined and replaced if necessary before leaving the pay office, but not a bean of help, if he had once gone outside the door with it ! In a very different sphere, the loss of a leg on service brought with it a monthly allowance of thirty rupees for the maintenance of a palanquin ; with presumably not a penny after retirement. As the " Colonel, chief engineer," drew at all times just twice that sum for a palanquin " and conveyance," there seems a tacit suspicion that chief engineers of 1800, like the Queen of Spain, had no legs.

A pertinent allowance was that for the purchase of camp equipment. The sums varied from Rs. 400 for a subaltern to Rs. 1,600 for field officer, the equipment being expected to last for two years. This cannot, of course, be compared with the much smaller expense of nowadays, when officers move about on service with far less kit and far greater fighting efficiency.

So much for the outstanding items of pay and allowances. There remain a few other details worthy of notice. The first of these is dress. The Sappers are dealt with in a single paragraph, dated 1800, being the most recent order prior to the publication of the book. It may be given verbatim :—

" The officers of the engineer corps to wear jackets with black velvet facings, cuffs and collar—the ftrap of the epaulette to have a black ground—in every other refpect the jackets are to be made and embroidered, and the appointments of the officers of this corps to be the fame as thofe of the artillery, except that they are to wear round hats, inftead of caps, plain black ; with the cockade on the left fide of the crown, and a button of the fame kind as thofe of the jacket."

The artillery dress quoted is given at great length, of which the broad details are :—

Jacket : blue, with red facings, cuffs and collar, and some plain gold embroidery.

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Epaulettes: straps two inches broad, red ground, with 8 embroidered stripes of gold: the bullion plain, three inches long and 24 in number with a proportionate quantity of fringe.
Buttons: three-quarters of an inch in diameter, with the Company's crest engraved on them.
Waistcoat: plain white, single-breasted.
Pantaloons: plain white.
Stocks: black leather, without false collars.
Boots: half boots cut round at the top.
Sashes: crimson silk, with a rose, worn at the left side.
Gloves: buff leather.
Breast-plate: oval, not exceeding the breadth of the belt (*sic*) with the honourable company's crest engraved on it.

In all, probably a pretty uncomfortable outfit for the Bombay Presidency climate, and not very conducive to health.

The badges of rank are interesting, they are given only in connection with the epaulettes, viz.:—

Subalterns and Captains:—One epaulette on the right shoulder.
Field Officers:—An epaulette on each shoulder.
Lieutenant-Colonels:—One spangled star of six points in the centre of the strap of both epaulettes.
Colonels:—Two such stars on each epaulette, one at the centre of the strap, the other at its lower end near the bullion.

Generals and Staff Officers must have been regular peacocks, from the paragraphs-full of decorative stuff which they were to wear.

Whilst on the subject of dress, there is an amusing reference to Indian officers. Nowadays, being sophisticated, we say for instance "Ankle boots and putties will be worn with service dress," a nice and specific instruction. Not so the old Bombay Ducks of 1769. They laid down, on the 3rd January of that year, that:—"The black (*sic*) officers are to wear boots, and constantly appear on duty in them." Anyway, it must have kept the black officers cool.

Eight years later, the order that "Safhes are to be worn uniformly round the middle," conveys the irresistible suggestion that a qualified field officer or two had found them slipping naturally upwards.

As perhaps the winning curiosity of spelling, and incidentally the historic initiation of proper commissioned rank to Indians, we read that:—

> "The hon'ble the Governor confents to the fubahdars and jumbledaurs of the fepoy corps having commiffions, agreeable to their general requeft."

Let us hope they got them somewhat cheaper than the British officers of those days, amongst whom even a captain was fleeced for

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£8 15s. as the price of his commission. No wonder that, as late as my year of joining the Corps, there was a current yarn that the formal deposit of one's commission with Cox & Co. stood good for an overdraft of a fiver when desired.

Finally, reverting for a moment to the subject of works, we find in 1796 the official birth of the "hoonwallah." He is not called that. The order runs :—

> "They (the board of Governors presumably) recommend, as an encouragement that the Muccadams who are inftrumental in collecting Coolies, fhould be received with them, and retained if capable."

Nearly a hundred and twenty years later, I once objected to paying rather enhanced coolies' wages to the gangman bossing each small gang, his contribution in actual work being *nil*, since he merely ejaculated a very loud and nasal "Hoon, hoon," each time the gang pulled on a rope or shifted a load. I was told to let be, as the "hoonwallah" was one of the oldest and most respectable institutions in India. I now see that under, to my mind, a much less picturesque and descriptive name, he was governmentally baptized in 1796. What a pity that he has no counterpart in the officer cadre !

ADDISCOMBE.
From an old engraving.

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WORK OF THE R.E. WITH THE SHANGHAI DEFENCE FORCE.

PART I.

INTRODUCTION.

THIS Report has been prepared for the following purposes :—

(*a*) As a record of the work done.
(*b*) For the benefit of a future Shanghai Defence Force, should a similar emergency arise in, say, 10 or 20 years' time.
(*c*) For the benefit of any similar force sent off to any other city at a moment's notice.

It deals chiefly with the work in connection with defences, accommodation and stores. To make it complete as regards all aspects of R.E. work, short accounts of the activities of the Litho-Printing Section, and Army Postal Service, have been added.

PART II.

DEFENCES AND WORK OF THE 10TH FIELD COMPANY, Q.V.O., MADRAS SAPPERS AND MINERS, 1927.

Situation in February, 1927.—On 17th February, the British Force in Shanghai, most of which had arrived the previous week, consisted of Headquarters 20th Indian Infantry Brigade, two British and three Indian Infantry Battalions, one Company Sappers and Miners, and certain administrative units.

The Shanghai Municipal Council maintains a Volunteer Corps for Internal Security, and at this time it was composed of :—

Cavalry ..	..	2 troops.
Artillery ..	..	1·4 gun battery 4·5" howitzer.
		1·4 gun battery 2·75" howitzer.
Engineers	..	1 troop.
Armoured cars	..	1 company of 8 cars.
Infantry ..	..	800 (in national companies).

It was anticipated that, when the Chinese armies, engaged in civil war, arrived at Shanghai, there would be an outbreak of mob violence within the Settlement, which would be aggravated if Chinese troops were permitted to cross the Settlement boundary. A further consideration was the possibility of one or other of the Chinese armies attempting to rush into the Settlement and take over control, perhaps using the Chinese city as a line of approach.

Political situation on 17th February, 1927.—The International

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Settlement, administered by the Shanghai Municipal Council, adjoins the French Settlement and is only separated from the Chinese city by a thin strip of town.

The British Force had no international standing and could be quartered on British-owned property only. With the consent of landlords, occupation of other property was possible.

On the declaration of a state of emergency by the S.M.C., difficulties caused by this restriction ceased as the British Force assumed an international standing

Not, however, until the situation had become so critical that tactical considerations overruled all others, could defensive measures be carried out unhindered by any restrictions.

Roads both inside and outside the Settlement were usually owned by the S.M.C., and could be used by the Defence Force.

The Railway was the property of the Chinese Government, while the Soochow Creek was ruled to be an international waterway.

No help, in their official capacities, could be expected from members of the S.M C.

Rôle of the S.D.F.—The Provisional Defence Scheme, issued by H.Q. 20th I.I. Brigade, laid down the *rôle* of the British Force as being :—

1. To suppress violence within the Settlement if called upon by the Shanghai Municipal Council.
2. To prevent destruction of foreign property. (A foreigner being anyone not Chinese.)
3. To take up a defensive position to prevent mob or troops entering the Settlement.

Duties of Field Company S. and M.—The duties allotted to the S. and M. Field Company were described in the Defence Scheme as being :—

1. Preparation of materials for, and design of, defences.
2. Location of materials in suitable dumps and distribution thence to required sites.
3. Supervision of the construction of the defences.
4. Execution of special R.E. tasks required by O.C. sectors.
5. Arrangements for armouring lorries if required.
6. Arrangements for searchlights as required.
7. Arrangements for cutting railway if required.

Provisional Defence Scheme.—The scheme allowed for alternative defensive lines, subdividing the front into eight sectors, of which numbers one and five were considered of major importance.

With slight modifications, the actual line first taken up has always been adhered to, though alterations in unit and brigade boundaries and frontages have taken place with the variations in strength of S.D.F

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In February, the frontage, approximately 15 miles, was so long, with respect to the troops available, that the system of defence was based on :—

1. Section posts on the passive-defensive, crossing the front of the position, and sited so as to avoid a mob being able to brush them aside.
2. Infantry patrols (with a possibility of armoured lorries for use in the streets).

Nature of perimeter.—Apart from grave mounds up to nine feet in height, the country is uniformly flat and much intersected by creeks. Lines of approach to Shanghai are the Soochow Creek, Whangpoo River, the railway, and roads which cease a few miles from the city.

At depths from two feet to four feet, the ground is water-logged, the soil being of fine alluvial deposit.

In winter, everything is bare, while at other seasons foliage and crops obstruct the view.

No. 1 sector :—For the most part through open country and presented no difficulty.

No. 2 sector :—Through town area, which is very closely built and cut up by innumerable alleyways. The salient of Hongkew Park was eventually taken over by the Japanese, who had material interests there, but two companies of the S.D.F. remained in billets in the Public School for Boys, for which defences were put up.

No. 3 sector :—The line ran through the town, and was a difficult one to deal with. Just across Boundary Road was the North Railway Station, which Chinese troops were utilizing. The Chapei District, considered to be an area of potential trouble, where gunmen and strikers foregathered, was also the width of one street away from the line.

No. 4 sector :—Contained the mill area along the Soochow Creek, the mill hands being peculiarly susceptible to disaffection.

No. 5 sector :—Traversed open country with good fields of fire.

No. 6 sector :—The dividing line between the International and French Settlements, and was considered of a secondary importance.

No. 7 sector :—The Pootung area on the east of the Whangpoo River.

No. 8 sector :—A modification of the western defensive line marked on the map, being practically the Western Settlement boundary as far as Robison Road, and then east to left flank of No. 4 sector. This was an alternative line which was never adopted.

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Policy affecting choice of line.—1. Outside the boundary of International Settlement, except for municipal roads, the country is under the Chinese Government. It was desirable that no offence should be given by any act of occupation by the British.

2. The policy that the normal life inside the Settlement should proceed without interference meant that roads, waterways, etc., should be left as unobstructed as possible.

3. The greatest care had to be exercised to avoid giving offence to property-owners of other nationalities, whose land could only be used with their consent.

General.—The French had their own defence scheme and works were executed in accordance with this, while, prior to the arrival of the S.D.F., the S.M.C. had also had carried out a good deal of work, primarily of the nature of wiring and barricades.

Factors Affecting Design of Works.

1. The anticipated trouble was more from strikers, mobs, and gunmen than from an attack by armed and well-organized Chinese forces.

Artillery fire was not considered likely, and the defences were primarily constructed to give protection against intermittent rifle or M.G. fire, and bombing.

It was considered likely that the effect of a Chinese bullet might be less than that of one of ours, as ever since 1925 occasions had arisen when war had been waged in China with varnished paper bullets.

2. All-round defence was aimed at. Small posts were built complete, larger ones, front first and rear added afterwards, or were raised in height as opportunity arose.

3. In February, one brigade held the whole front, necessitating a large number of small scattered section posts. Later, in No. 5 sector, on the arrival of more troops, selected posts were enlarged as platoon posts and the remainder abandoned.

4. Owing to the water-logged nature of the country, breastworks or a combination of trench and breastwork were built. Very occasionally a rise in the ground (grave mounds being avoided) permitted of normal trench work being carried out.

5. In the town, all posts are completely overlooked by houses. As far as considered essential, posts were eventually roofed with ⅛" M.S. sheets, concrete pavement slabs, or road metal to render them bomb-proof. Some houses were earmarked for defence purposes in case of trouble and, later, several were occupied.

6. To avoid dislocation of normal life in the Settlement, posts in the streets were sometimes sited and built to permit the use of roads and shops, to the detriment of their protective value. Wire entanglements to some extent also conformed to this policy.

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7. In the town areas, the earlier posts were built of sandbags containing sand or road metal, or of C.G.I. revetment, filled with road metal.

8. In open country C.G.I. revetment, sandbags and bamboo hurdles were used.

Employment of the Field Company, S. and M.—The Unit arrived from India on mobilization scale of equipment, clothing, etc., on 17th February, disembarked on 19th under urgent orders, and moved to Thorburn Road into tents.

Until the arrival of the C.R.E. on 28th, there were no other R.E. representatives in Shanghai. For three weeks from the date of arrival, one officer acted as Garrison Engineer, assisting the Staff Captain in his work of billeting, and also was *liaison* officer with the Italian Landing Party.

The remaining three subaltern officers were detailed to work with officers commanding the sectors of the defensive lines, being employed on numbers 1 and 2, 3 and 4, 5 and 6, sectors respectively.

Reconnaissances had been commenced on arrival of H.Q. 20th I.I. Brigade, and were carried on with by the Field Company Officers, in conjunction with the infantry.

On the information obtained, materials were ordered and delivered at sector dumps, to be available when needed.

The principal requirements were stores for entanglements, and corrugated iron and sandbags for revetment, a stock of which was gathered together at Ward Road Camp, in which the Field Company was located from 24th February.

For some days there was a continuous delivery of material by P.W.D. and civil lorries, while, when the " flap " was on, stores were off-loaded and distributed immediately by our own lorries to the sites of the work. The men available for this loading work were usually the drivers, the guard occasionally lending a hand, as the demand for stores was insistent and seemingly insatiable, and all Sappers were out on works.

22nd February.—In the evening, a Commanding Officers' Conference dissolved on receiving news that shells were falling in the French Settlement and that refugees were coming into the city. The shelling proved to be that of a Chinese gunboat shelling the Kiangnan Arsenal, and late at night one battalion was moved into the line.

25th February.—Provisional Defence Scheme came into force. Acting on sanction received the previous day, wiring was commenced on numbers 1 and 2 sectors. This was considered to be urgent, and Chinese coolies were obtained to assist. Japanese forces occupied the Hongkew area.

26th February.—The Italian detachment took over one mile of front on number 2 sector. They showed themselves to be extremely

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keen and willing to co-operate in every way. One section of Sappers moved out to number 4 sector. Defences on sectors 2–5 were commenced.

27th February.—Wiring was in hand in sectors 1 to 5, and certain roads were barricaded.

1st March.—Four searchlights (flood lights) were arranged for at certain points on the Soochow Creek. These were installed by the Electrical Department, and operated by the infantry.

2nd March.—A second section of Sappers moved to number 5 sector on detached duty.

3rd March.—Priority work was ordered on 2nd line opposite Chapei.

4th March.—Another section went into billets in number 2 sector. Up to this time lorries had been used to take Sappers out to work.

6th March.—Erection of second line wire on numbers 3, 4, and 2 sectors, in that priority, was ordered.

10th March.—Four R.E. Serjeants from England reported for duty with the Company.

20th March.—Priority work was ordered on the previous day on number 1 sector, and 10 C.G.I. revetted breastwork positions, to hold from 1 to 2 rifle sections each, were prepared. Those on the road were made with road metal, the remainder being filled with earth

21st March.—"State of emergency" declared and S.V.C. called out. Civil war was carried on in Chapei all day and during the night. All entrances to the Settlement were barricaded, and troops occupied the line.

At 8 p.m., Headquarters Section was ordered to Hongkew Park to assist in the construction of additional defences for the Public School for Boys, where two companies of infantry were billeted. Two sandbag posts were built, and another one made of kerb-stones and pavement slabs taken out of the footpaths.

At 10 p.m., the remaining two sections (now at Company H.Q.) were called out, and proceeded to various places opposite the Chapei area and the railway station, where they constructed a number of posts and obstacles, and returned between 6 a.m. and 9 a.m. the next day.

From 24th to the end of March, defences opposite Chapei were developed.

Additional posts were erected, while heavy gates and improvised concrete blockhouses were brought into use. Many posts were provided with bomb-proof roofs, while others were either made weather-proof or given sectional huts for the use of the garrison.

This work continued in April, which proved a quiet month.

On May 9th, the barriers leading into the Settlement were opened, and on the following day curfew was abolished. From then on, the

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policy was to maintain only such posts as were considered essential, or to replace them by a more permanent article, such as concrete, when they had deteriorated and become unserviceable.

Early difficulties.—February and early March were wet and cold. Troops were accommodated in tents, hutments or billeted in godowns and mills, and the Race Course, and some units from India, having been mobilized, were equipped with only one pair of boots, one suit of thick and one suit of thin clothes per man.

When work was ordered, it was usually of an urgent nature, and necessitated long hours of work carried out in the rain, with no facilities at the end of the day for drying and changing boots and clothes.

With a front of 15 miles, distances to be covered were considerable and work fell heavily on R.E. officers.

The greatest difficulty was experienced in the crowded town areas, where alleyways are very numerous, and where the policy of allowing normal life to proceed unhindered produced many worries for all concerned. This latter difficulty was later on very largely done away with, when the " state of emergency " was declared.

Wilful damage to sandbag posts and the stealing of pickets from entanglements, even though frequent patrolling was resorted to, was another source of trouble.

SUPPLY OF R.E. STORES.

Authority was delegated by H.Q. 20th I.I. Brigade to O.C. Field Company S. and M. to deal direct with P.W.D. as regards the purchase of material required. This authority was confirmed by C.R.E. on his arrival on 28th February, and held good until 31st March.

Without the assistance given by P.W.D. the work carried out in the early days of the British Force would not have been possible. At very short notice any kind of material was produced and delivered at selected sites, while the officials were prepared to give their help at any time.

Barbed Wire.—Eventually 800 tons were purchased and brought across the Whangpoo River. Quantities were dumped at the sector R.E. dumps, for use on the line, the bulk being unloaded at Ward Road Camp, which later became the R.E. stores.

Timber.—Posts for entanglements were distributed similarly, usually being 12-foot Foochow poles suitably cut.

Planking and scantling for other works could also be procured at short notice.

Sand and road metal.—Available at various P.W.D. depots in the Settlement. The normal procedure was either to send sandbags in lorries to the depots, with working parties to fill them there for onward dispatch to the site of the work, or for P.W.D. to deliver where required.

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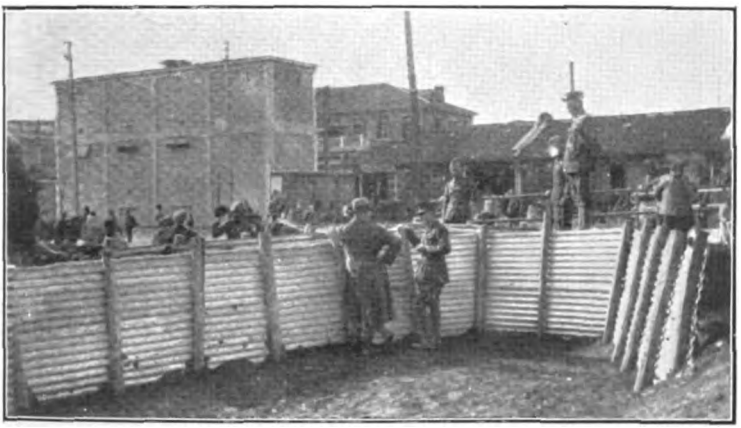
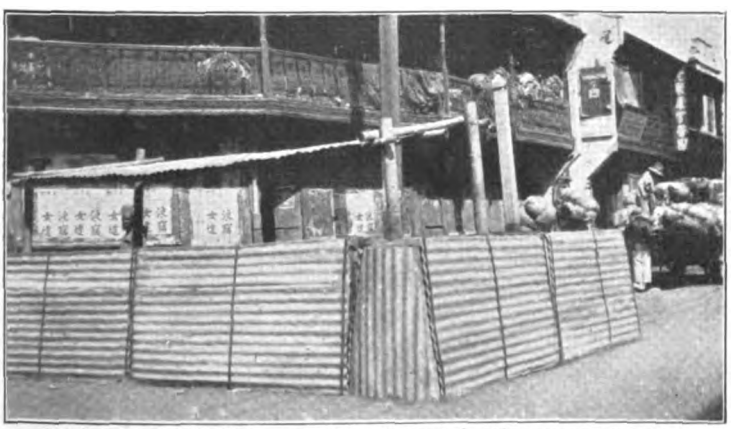
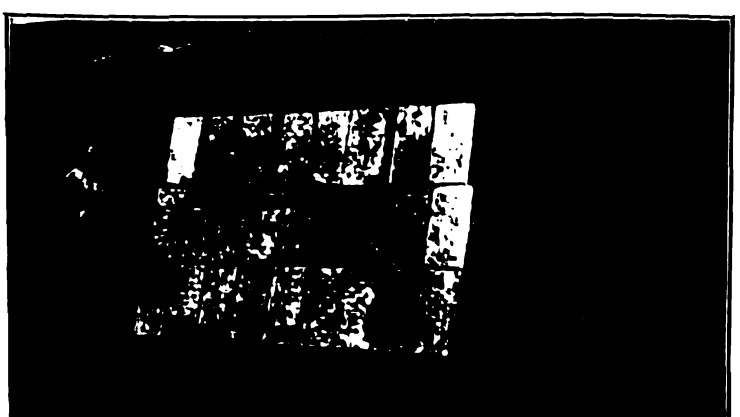
WORK OF THE R.E. WITH THE SHANGHAI DEFENCE FORCE.



No. 1.—C.G.I. revetment with earth filling completed to give all-round fire. Type used in No. 1 sector.



No. 2.—C.G.I. boxes with 3/4 in. × 1/8 in. flat iron bands around and internal ties, to hold sand. Used by Italians to replace sandbag posts when the latter had deteriorated.



No. 3.—Example of use of extemporized barricades, using 2 ft. × 1 ft. × 2½ in concrete paving slabs on frame.

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No. 4.—Platoon post : loopholed hut with vertical walls C.G.I., and 9-in. road metal at important street junction in town area. Provided with bomb-proof roof.

No. 5.—Concrete blockhouse guarding bridge head.

No. 6.—Fortified house enfilading road at North Railway Station. A room on the ground floor was strutted, and the wall thickened by adding a layer of 18 in. sand.

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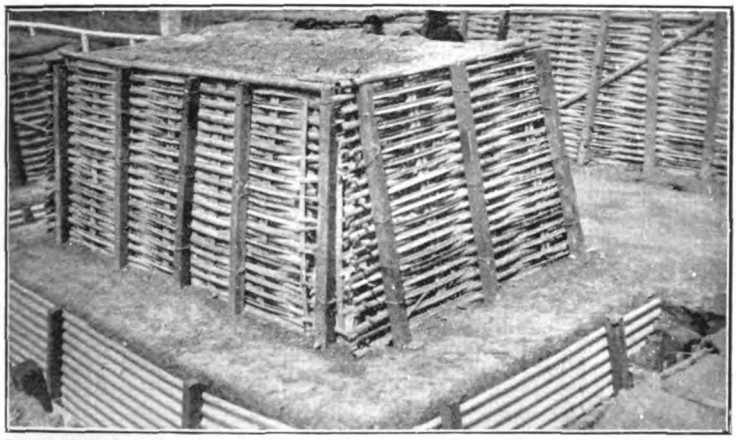
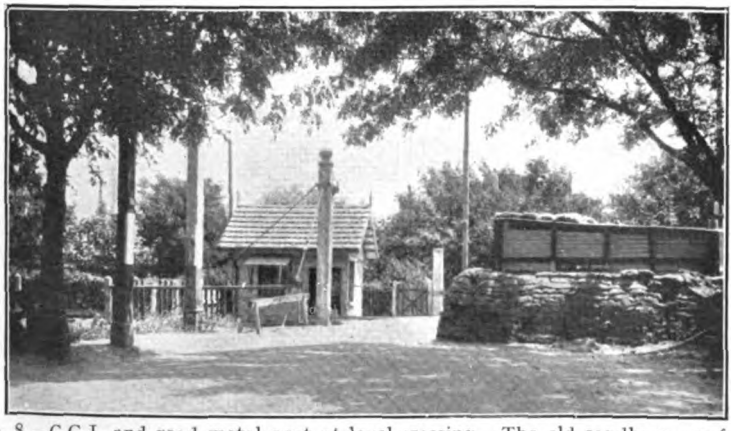
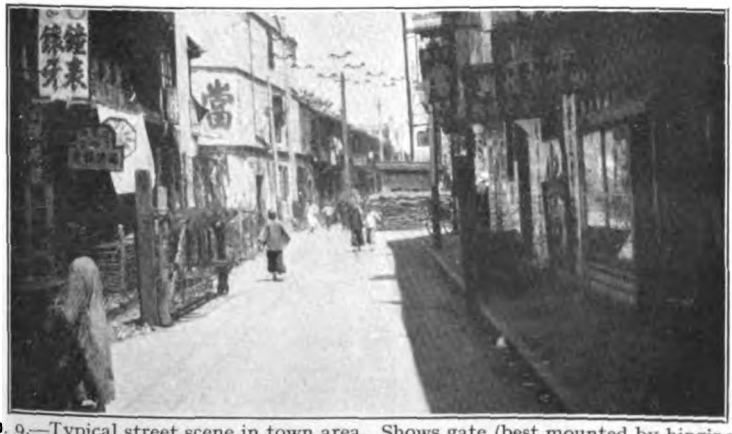


No. 7.—Bamboo hurdles (10 ft. × 5 ft.) used for revetment in No. 5 sector.



No. 8.—C.G.I. and road metal post at level-crossing. The old sandbags are from original post.



No. 9.—Typical street scene in town area. Shows gate (best mounted by hinging to post by use of 1-in. thickness iron collar) pivoted on stone slabs with outer end running on a solid wheel roller. Secured, when shut, with padlock and chain. Concrete post at street corner.

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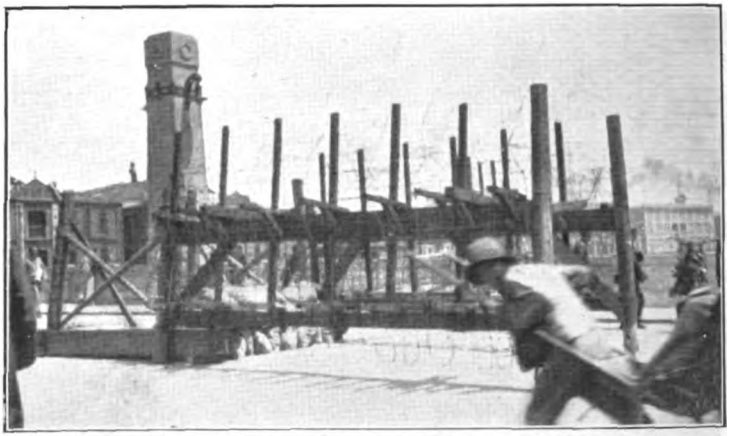
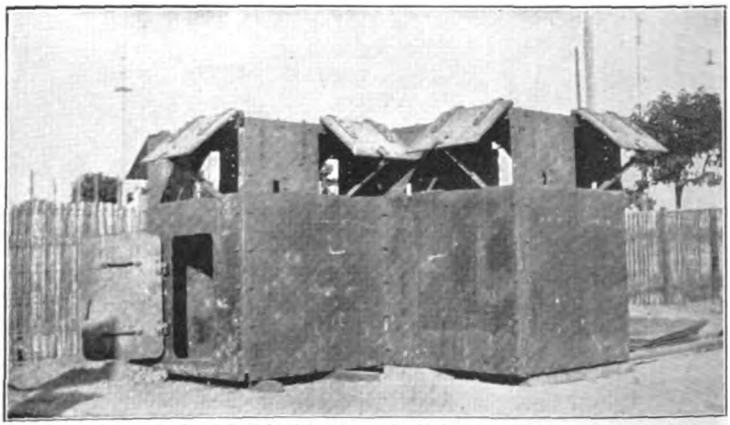


No. 10.—Shows method of mounting large gates on crown of bridge where excavation into roadway was not permitted.



No. 11.—Experimental M.S. blockhouse. Sufficient parts were ordered to make
(*a*) two 10 ft. × 5 ft. blockhouses,
(*b*) one 10 ft. × 10 ft
(*c*) one L-shaped 10-ft. frontage as in picture.
Made in 5 ft. panels, two thicknesses of 3/8 in. M S. sheets being used. Loophole plates 3/4 in. M.S. hinged for coolness in summer. Roof single 3/8 in. M.S. Erection of 10 ft. × 5 ft., seven men 4½ hours.

No. 12.—Concrete blockhouses: loopholes cut as required for M.G. and L.G. 4 ft. × 1 ft. × 4 in. slabs with double X.P.M. reinforcement. Erection, 12 men from 6 to 8 hours: digging holes for posts, additional 3 to 9 hours, dependent on quality of road; a pneumatic drill was sometimes available for this and for making holes for entanglement pickets.

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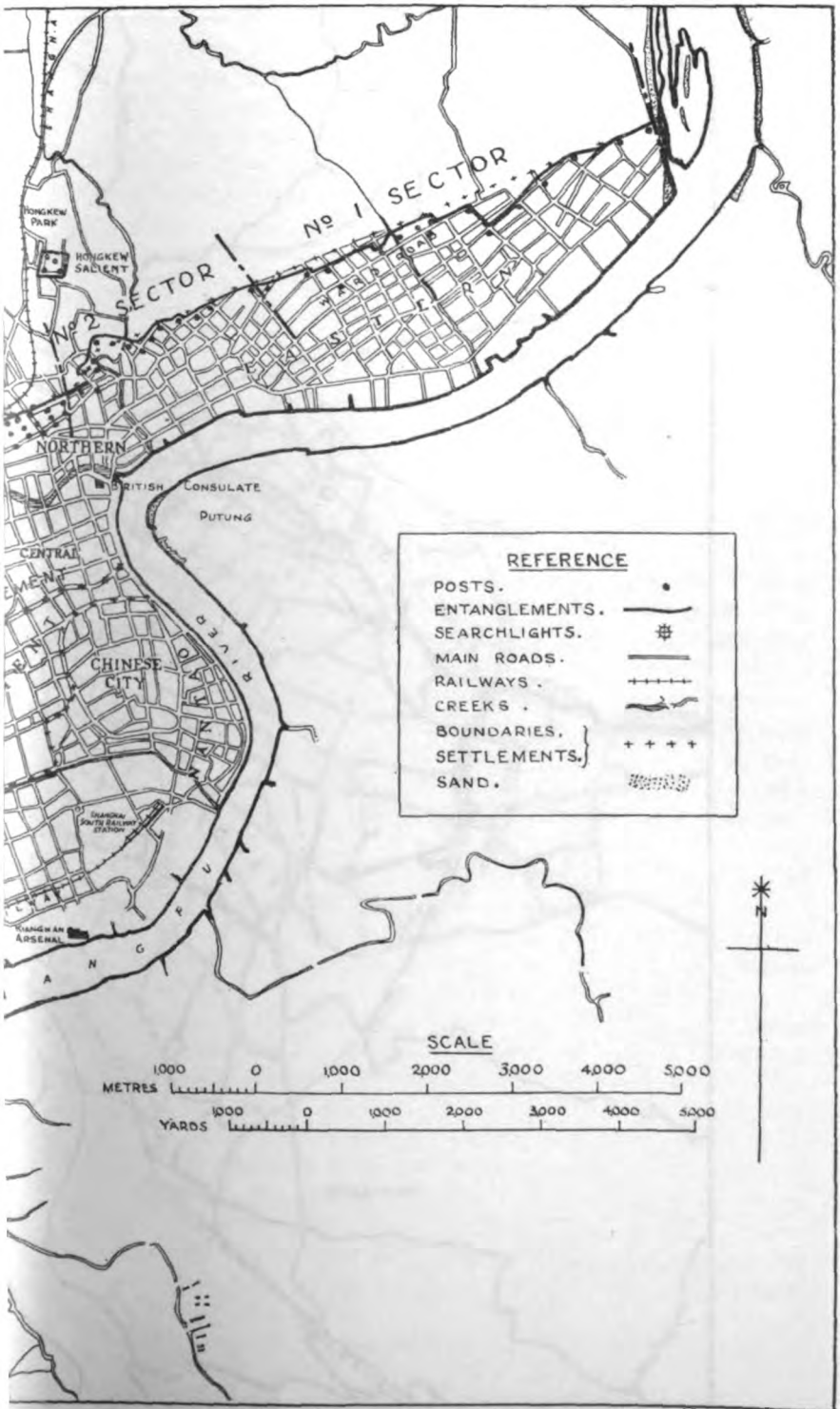
ANGHAI.



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Concrete.—The P.W.D. concrete-ware yard had in stock a quantity of grooved posts and 6-foot slabs (3 inches thick) for the building of compound walls by the unit construction method.

On 28th March, these were taken into use and erected as block-houses at several places opposite the Chapei area, while special members (including roof-tiles) were being cast to a new design, on the same principle, for blockhouses. This experimental type was modified later.

Other stores.—All other material, stores and tools were obtainable through the P.W.D. who arranged a prompt supply.

Sandbags.—Ordnance had 300,000 sandbags brought from India, and a few tools.

Transport.—In February and early March, seven lorries and four motor cars were allotted to the Field Company.

Conclusion.—The map shows the Settlement boundary, without making clear that on the Chinese side of it there is a town as closely built as that on the Settlement side.

It is also on too small a scale to indicate the obstacles and gates enclosing posts. It was laid down as a matter of policy that, as far as possible, all posts should be wired round and sometimes have double gates. In the town, in important areas, four gates were necessary for each position on cross roads. The large gates were made in P.W.D. workshops, whose facilities were greater than ours.

"Concertinas" were found to be unsatisfactory for blocking streets.

The elapse of some days between the arrival of troops and the commencement of work was due to the fact, already noted, that nothing could be done without sanction from the S.M.C., which was the authority responsible for gauging how serious the state of affairs had become.

This period was filled in by carrying out reconnaissances and preparing stores in readiness for any eventuality.

Internal Security troops held positions on bridges and important points within the Settlement, and patrolled day and night during period of trouble.

The experiences of taking part in the defence of the city under abnormal conditions has been of considerable interest and has proved valuable training to the Field Company.

Sections were often billeted away from Company H.Q., with section officers in close co-operation with battalion commanders, while the O.C. Unit was dealing with headquarters of brigades and the Public Works Department, until the arrival of the S.O.R.E. on 9th March, when the latter duties were taken over by him.

Co-operation between the R.E. and infantry was always on the friendliest basis, the extreme keenness of the infantry being remarkable.

(To be continued.)

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ENGINEERING MODELS.

By LIEUT.-COLONEL E. W. C. SANDES, D.S.O., M.C., R.E.

THE vast scope of modern Civil Engineering should lead an instructor to adopt any methods which will save time and impress engineering forms and details indelibly on the minds of his pupils. There is little doubt that imagination, by which I mean the ability to think in three dimensions, is of supreme importance in engineering. It is a gift which some possess from childhood, but in most people its development must be assisted. To these less fortunate ones a concrete illustration of theory is of great help and saves them many hours of poring over diagrams which convey little to them and are soon forgotten. If an instructor can show an actual structure to his pupils they will derive twice as much benefit from his lecture, and will remember it ten times as long, as if his remarks are illustrated only by blackboard drawings or printed diagrams. In lectures to men who have already developed the imaginative faculty the use of diagrams may suffice; models are to them merely the confirmation of what they have already imagined. My remarks do not refer to such instruction, but to that of comparative beginners, and particularly those who have never built ramshackle houses of wooden bricks, or dissected the nursery clock with a nail, in their childhood.

An engineer once told me that he thought that instruction with models was actually harmful. His view was that it destroyed originality and retarded the development of the ability to read and understand engineering drawings. He said that men instructed with models slavishly copied the details of those models when making their own designs, instead of examining and adapting the drawings of similar structures, and that, without their models, they were lost. There might be something in these opinions if engineering models were so numerous that all types and details of structures could be shown and were always accessible to students; but the variety of structures being so great, life so short, and funds so scarce, this heavenly model room remains a dream, and no student will find in his earthly model room more than one or two of the examples which he needs. The remainder he must get from diagrams of works, and palpably he will read those diagrams more easily and quickly if he has already studied others with the assistance of models. A student of engineering must be encouraged to exercise his ingenuity, but the presence at the back of his mind of a clear picture, formed from a model, of how certain difficulties in design are overcome in practice

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will keep him on the right lines when his inexperience might otherwise send him off the rails.

Unfortunately, as the science of engineering advances, models become out of date and may then lead students astray. This objection, however, applies to all engineering structures, and a model can be altered or replaced cheaply, while a full-size structure cannot. It is easy to attach to any model, in addition to a printed description, a note showing how it differs from the most recent practice in general design or detail—in fact to indicate errors—and when it becomes obsolete it can be relegated to an engineering museum if it has any historical interest.

Instruction given on an engineering work in progress is preferable to instruction on that work after its completion ; and instruction even on a completed work is usually better than instruction with a model. But it is difficult to locate an engineering college where there are structures illustrating *all* branches of civil engineering within easy reach. In, or near, manufacturing centres in England examples of many branches of engineering may be studied, though at the cost of considerable time spent in travelling ; but, in India or the Colonies few such facilities exist, and it is there that models become so valuable. Methods of construction cannot be shown in a model, though progressive stages can be depicted, and hence the superiority of periodical visits to actual works in progress. The model scores, however, in that it is always available for examination ; a student can return to it again and again to see some point of interest or detail which he needs for his design work in college. The model fails to show the organization of labour, the methods of the supply of materials, and the preparation of the site, though these can be dealt with in a printed description. To reap the full benefit of instruction with a model, the class should be formed of not more than six or eight students, so that all may have access to the model and can ask questions—intelligent or otherwise. If they ask questions it shows at least that they are observing the model, and if they are observing it they are learning from it.

The conclusion at which we arrive is that, if modern engineering works of all kinds exist and are increasing in number close to an engineering college, a civil engineering model room is a luxury ; but that, if such works are not easily accessible, a model room is invaluable to facilitate and expedite training, and to save expense in travelling.

An engineering model room should be attractive, though it need not be artistic. The models are meant primarily for instruction, but if painted in bright colours they will be more likely to catch the eye. The repetition of identical features should be avoided if possible, and at many places (*e.g.*, at joints in steel work) portions should be cut away to show interior details. The scale will depend on the size of the smallest detail which must be shown. For steel bridges, 1/6th

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or 1/8th full size will usually be found suitable, but models of details may be on a scale of 1/2 or 1/3 and occasionally the scale for a complete structure may be as small as 1/60. A model should preferably be small and portable, though this is not essential if there is ample space for students in the model room. The model of a portion of a large Baltimore Truss-type girder-bridge with overhead bracing, illustrated in this article, is an example of a fixed model large enough to show the necessary details on a suitable scale.

Every model, unless of the simplest type, should have printed, framed and glazed descriptions and diagrams (and for bridges, calculations also) mounted on an iron stand attached to it, or near it, so that the presence of an instructor is not essential. If a student does not know what the model represents, and what it is intended to teach, it is of little value except as an ornament. In the case of bridge models, if there is space to show the calculations and stress diagrams of the full-size bridge, so much the better. The framed plan, sections and elevations should show the dimensions of the full-size bridge and not the model dimensions, which can be obtained easily by measurement. The diagrams should also show the scale of the model, in addition to their own scales, with reference to the full-size bridge. It is rarely possible to provide diagrams on so large a scale as the model, as there will then probably be no space for the description, calculations and stress diagrams, if these are to be mounted close to the model for easy reference. If the model shows a bridge which actually exists, photographs of the structure should be included, together with a note by the engineer who built it, explaining his difficulties and his methods of overcoming them. A small model can be mounted on a wooden base, which, when varnished, makes a convenient platform for showing the title in white lettering. A vertical framework of 1 in. x 1 in. x 1/8 in. angle iron, attached to the base and stayed with flat iron, can support the wooden frames holding the diagrams, etc., and should be of such a height that the frames are immediately above and behind the model. The diagrams should be coloured. If the model is large, and has a separate framework or stand for the diagrams, the framework should be so designed that it can be fitted closely to the model. All the diagram frames must be glazed, and, if the glasses are large, they must be thick to avoid breakage from distortion when the iron framework is moved. The frames should fit exactly within the angle iron to which they can be screwed, and the scales of the diagrams and sizes of the frames should be arranged accordingly.

Curiosity being a marked characteristic of youth, it will be found that any model with movable parts will soon be put out of order unless specially designed to be "foolproof." If it is not so designed, it must be kept under a locked glass case and operated only in the presence of an instructor. Much of its value for instruction is then

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lost. Accordingly, if there are any delicate working models in a model room (*e.g.*, signal apparatus) it is worth while to make foolproof editions of them, magnifying the delicate parts. As an example I may draw attention to the photograph of the foolproof model showing the slotting of Outer and Warner signal arms; the relative dimensions of the various parts are wrong, but a hammer would be needed to put the model out of action. It supplements and illustrates one part of a model of a complete mechanical interlocking system of railway signalling kept under glass protection in the model room at the Thomason College, Roorkee—a detail which is most difficult to explain by a diagram or verbally. It may be asked why it is necessary, or even advisable, to spend time in illustrating so small a point. To this I would reply that, though civil engineering instruction in a college must be mainly theoretical—time does not allow otherwise—a few examples showing the practical application of theory are valuable to *interest* a student and induce him to notice engineering details when he visits actual works, in fact to increase his powers of observation so that he will take nothing on trust, but will insist on understanding the why and wherefore of everything. In that frame of mind he will never forget what he has seen, and his design work will benefit accordingly.

Various materials can be used in the construction of models, but undoubtedly steel or brass are the best, though expensive. Concrete is heavy, rough and easily chipped. Wood is suitable for some models and is cheap and light, but in hot climates it warps, cracks, and is attacked by insects, and small projecting parts of wooden models are often broken. Model lashings, made of whipcord, should be glued in position and varnished. Road metal can be represented by very fine gravel or coarse sand consolidated with glue or size. Steel models requiring miniature rivets and angles must necessarily be expensive and difficult to manufacture. The steel Plate Girder model shown in one of the illustrations cost nearly £100; it was made by Messrs. Burn & Co., Howrah, Calcutta, who generously presented it to the Thomason College. The very large steel model of part of a Baltimore Truss road bridge with overhead bracing—also made by Messrs. Burn & Co.—cost about £250, including its metal pier and diagram stand, and the reproduction and framing of its diagrams and calculations, and its construction occupied more than one year. The cost of the average model, however, is fortunately much less than the figures I have quoted, and many wooden models cost little except in labour.

Brief descriptions of some of the civil engineering models in the Thomason College, Roorkee, as illustrated in this article, may be of interest. I have tried to show as many types as possible, but have had to omit several which are equally instructive.

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(1) 160 *ft. Span Baltimore Truss Bridge for Two Lines of Road Traffic* (3 *bays only*).

Scale 1/6.

Manufactured in 1927 by Messrs. Burn & Co., Howrah, Calcutta, and embodying the latest ideas in large steel bridging. One completed end of the bridge is shown, including its expansion bearings and pier and rocker bearings for the next span. The incomplete end of the model is supported on an iron frame. The best material for the model pier—five feet long—was difficult to decide. Brick, or plastered brick, would soon become chipped and ugly, and the fine corbelling would be difficult to cast in concrete; also none of these materials would provide a movable pier. Wood might have been used, but a huge block of perfectly seasoned wood without cracks or flaws was very difficult to get, and if the pier was built up with several blocks these would separate in the hot weather. Eventually the pier was made in cast iron with a steel plate screwed on to form the top, the walls being cast in two halves from one mould. This hollow and portable pier was then painted red and the brickwork lined in white. As the design of the bridge is complicated, only three bays are shown in the model, so that the details may be sufficiently large. The roadway is supposed to be of roadmetal on concrete resting on steel trough flooring, but the model roadmetal is actually made of Portland cement and coarse sand. A short length of completed roadway appears in the model. The separate angle iron stand carries wooden frames on both sides —on one side the elevation, plan and cross section of the full-size bridge, and on the other the stress diagrams for dead and live loads and complete data and calculations. On the model itself is a small frame containing a brief general description. The greatest care was taken to make this elaborate and expensive model complete in every respect and quite up to date. Its cost, and the labour involved in its manufacture, were fully justified by the fact that no large steel road bridges of modern type exist near Roorkee.

(2) 60 *ft. Span Plate Girder Bridge for a Single Line of* 5 *ft.* 6 *in. Gauge Railway.*

Scale 1/6.

Manufactured by Messrs. Burn & Co., Howrah, Calcutta, and presented to the Thomason College by that firm. The complete structure is shown, excluding the permanent way. All the dimensions are to scale, and every joint is properly constructed and fully riveted. Sleepers and rails are omitted, as these appear in a model of one end of a similar bridge which can be seen in the illustration beyond the large model. The piers, being of medium

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size, were each cut from a single block of seasoned wood and hollowed for lightness. A separate iron stand behind the model carries the coloured diagrams, calculations, description, and photographs a of similar existing bridge constructed, in 1921, about 12 miles from Roorkee. The illustration also shows in the background a very large wood and wire model of one cantilever span of the Lansdowne Railway Bridge over the Indus at Sukkur. This is an old model and not used for instruction, but it adds greatly to the appearance of the model room without occupying any floor space, and hence it is allowed to remain.

(3) *200 ft. Span Reinforced Concrete Arch Road Bridge with Suspended Single Roadway.*

Scale 1/60.

This model shows a road bridge constructed, in 1914, in the Terai District below the Himalayas—a wild tract with few roads and much jungle. The model is small and portable, so the framed diagrams, description and photographs are mounted on an iron stand attached to the wooden base. Bridges of this type have proved satisfactory and cheap under the special local conditions, *i.e.*, where a single span is essential, a narrow roadway under moderate loading suffices, expert supervision is constantly available during concreting, and the transportation of heavy steel sections is difficult. Under more ordinary conditions a steel girder bridge might be preferable. The model is made in brass, painted to represent concrete; a skilled fitter completed it in three months, and, excepting his pay, the cost of the model was small. It would be more valuable for instruction if its scale was rather larger, when portions of one arch and an abutment could be cut away to show the reinforcement and anchorage.

(4) *Reinforced Concrete Slab Floor on Pillars.*

Scale 1/8.

A small and portable model showing construction in various stages. One column is complete with its concrete foundation exposed; in another the steel reinforcement alone is shown, together with the reinforcement of the foundation, the main and subsidiary beams which are monolithic with the floor, and a part of the floor itself; a third column, and the beams and floor above it, are shown with the boxing in position. The description above the model explains the materials employed, the use and design of the boxing, the precautions and methods of work during construction, and other similar matters—in fact, the model gives a

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short lesson in elementary reinforced concrete work. The reinforcement is plated to prevent rust, since painting would have given a wrong impression that reinforcement should be so treated in actual work.

(5) *Slotting of Outer and Warner Railway Signals (List and Morse Type).*

Scale 1/3.

A working model which is specially designed to be "foolproof." The diagrams behind the model show the mechanism to scale, and any part of the model which may be damaged by rough usage is enlarged or replaced by something stronger. For instance, the signal wires attached to the higher ends of the slotting levers are replaced by two suspended brass links which can be pulled down and fastened to hooks on the wooden base; actual wires, pulled by model signal levers, would be broken in a few minutes. It will be noticed also that the signal post is very massive and dwarfed, and that the signal arms (of solid brass) are narrow and thick. If the model was made to scale it would have to be kept under a locked glass case, where it could not be worked by students alone, and its value for instruction would then be lessened.

(6) *Boat, and Barrel Raft, in a Bridge.*

Scale 1/8.

To show how a rowing boat should be strutted for bridge work, the design of a barrel raft using angle iron, the usual type of roadway for a light floating bridge, and the names of the various parts. A very portable and cheap model made from an old model boat and some waste material from an obsolete model of a roof. Before inclusion in the model, the boat was merely a pretty toy. Everyone knows what a boat is like, but everyone does not understand how a boat should be treated for bridge work.

(7) *Barrel Raft.*

Scale 1/12.

Another small model to show the lashings and design of an ordinary barrel raft, which are rather difficult to explain with diagrams. The model, of course, is not intended as a substitute for the construction of an actual barrel raft, but merely as a means of refreshing a student's memory after he has helped to make a barrel raft I would emphasize again that instruction on a work is preferable to instruction with a model.

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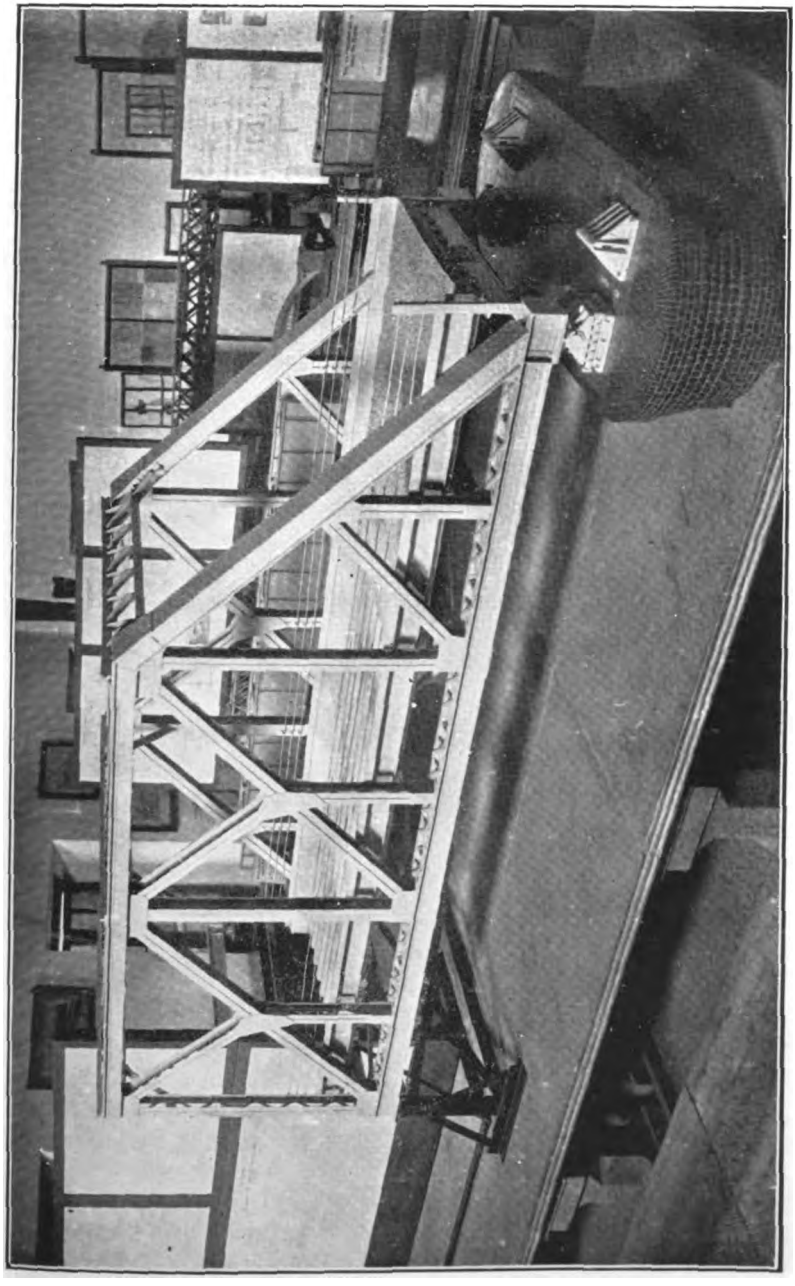
ENGINEERING MODELS.



No. 1.—160' Span Baltimore Truss Bridge for Two Lines of Road Traffic.

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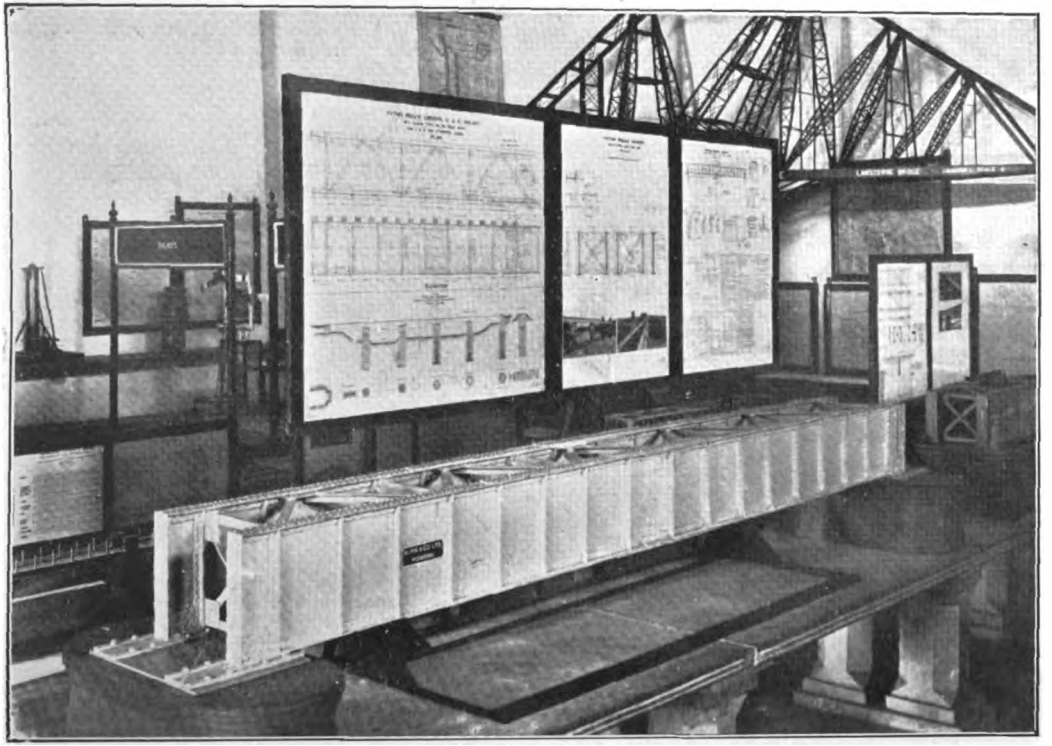

No. 2.—60′ Span Plate Girder Bridge for a Single Line of 5′ 6″ Gauge Railway.

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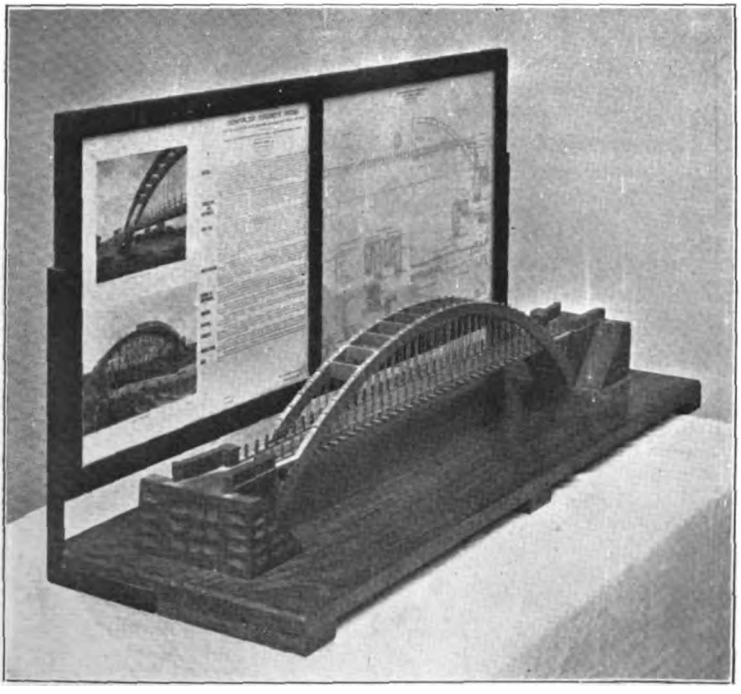
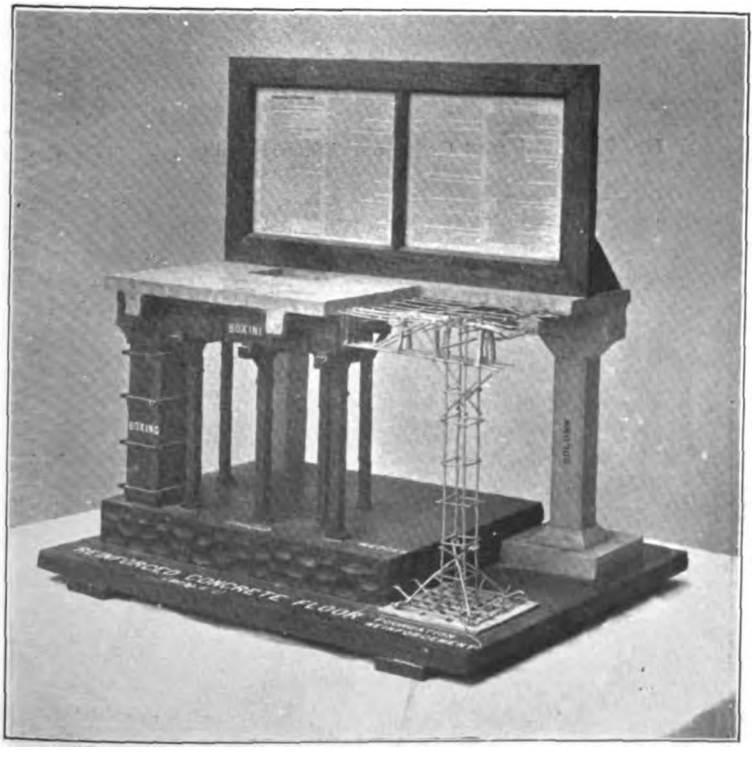


No. 3.—200′ Span Reinforced Concrete Arch Road Bridge with Suspended Roadway.



No. 4.—Reinforced Concrete Slab Floor on Pillars.

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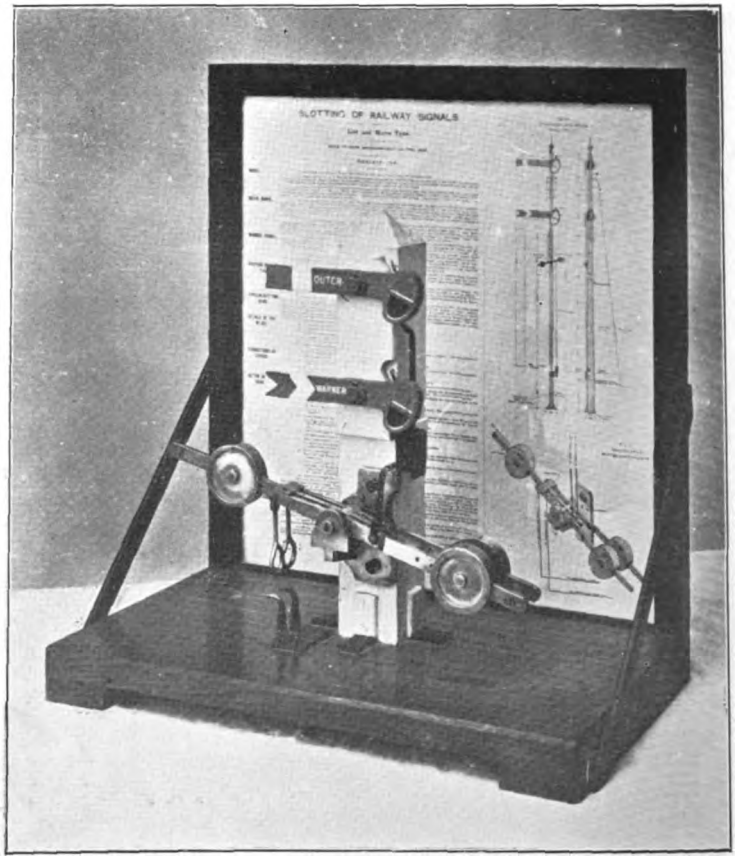
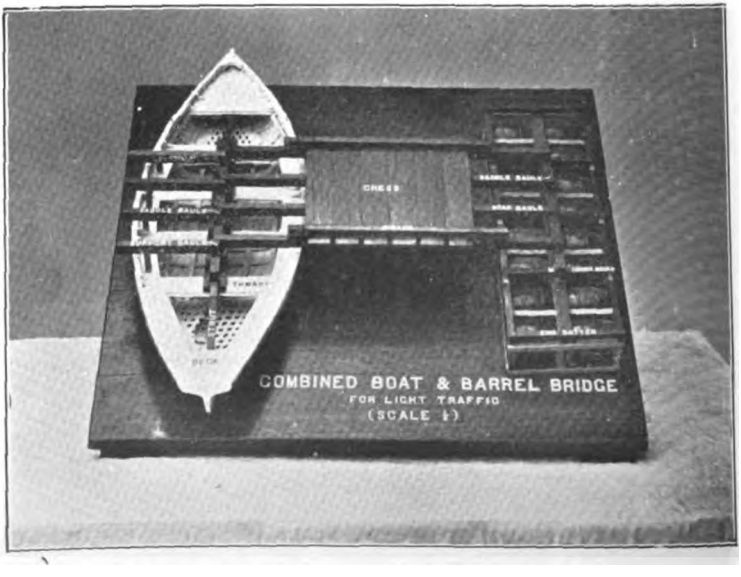


No. 5.—Slotting of Outer and Warner Railway Signals.



No. 6.—Boat, and Barrel Raft, in a Bridge.

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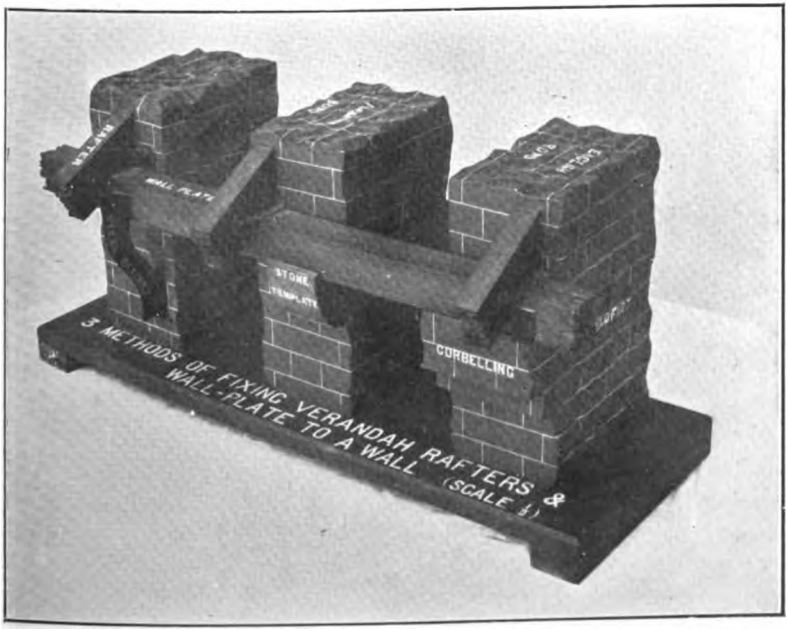
No. 7.—Barrel Raft.



No. 8.—Fixing Verandah Rafters and Wall Plate to a Wall.

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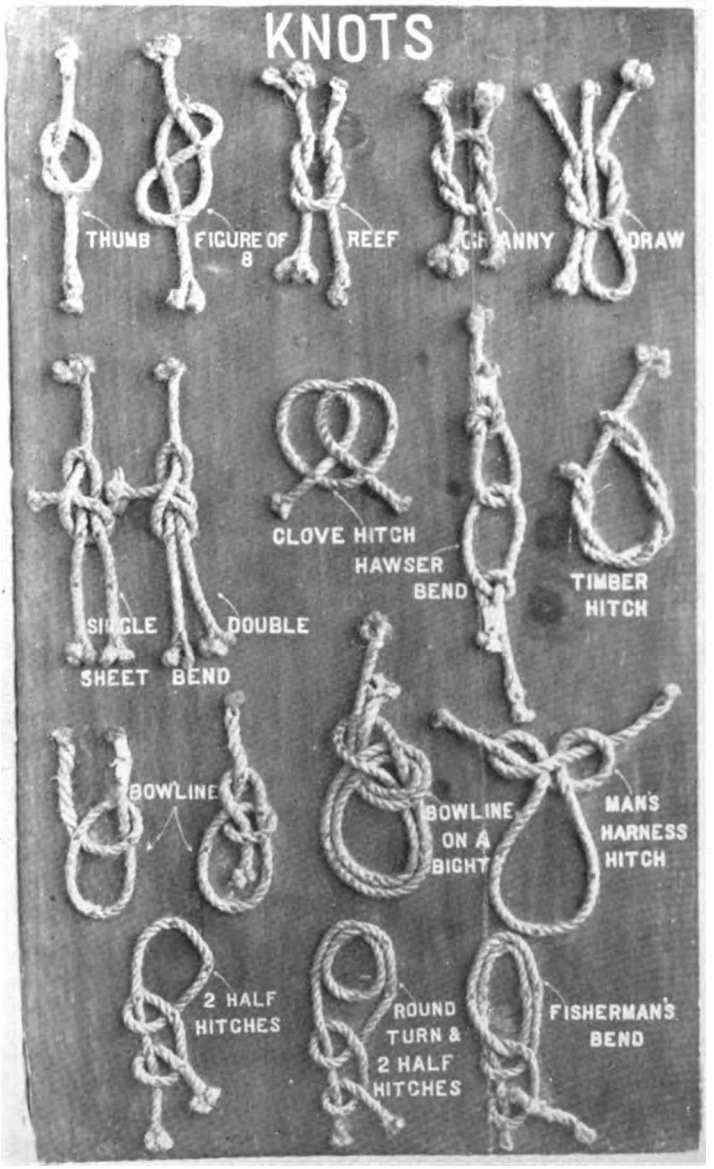

No. 9.—Knots.

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(8) *Fixing Verandah Rafters and Wall Plate to a Wall.*

Scale 1/2.

A simple wooden model showing three sections of wall with different bonds of brickwork, and three common methods (in India) of securing the rafters and wall plate in a verandah. Bonding of brickwork is easy to follow in a model, but much more difficult in a diagram.

(9) *Knots.*

Examples of knots made with thin line. The knots are varnished and screwed on to a varnished board, which can be taken wherever required for the practical instruction of students in knotting and lashing.

I have tried to give some examples of all types of civil engineering models, from the most expensive and elaborate to the most elementary and cheap. All those illustrated, except the first two, were made during the last few years at the Thomason College, where there are many others of all types. To a beginner, Engineering must often seem the dullest and driest of professions. He tires his brain in chasing the elusive x and in horrible and puzzling stress diagrams. He needs change and relaxation—something to look at without puzzling, something to encourage him to resume his chase or dive again into his diagrams, something which shows him in a concrete and pleasing form what his wearisome pursuits may achieve. He strolls into the model room, and finds the encouragement required to keep alive his interest in his future profession, so that one day he may perhaps hope to emulate the accomplishments of those great engineers who have left behind them so many proofs of their genius.

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A RAILWAY RAID.

A SIDE-SHOW ON THE FRONTIER—OF THE ALDERSHOT COMMAND.

By MAJOR I. SIMSON, R.E.

THE SCHEME.

1. Certain operations were carried out on 6th and 7th July, 1927, on the Woolmer Instructional Military Railway, at Longmoor Camp. The Units engaged were :—

1st Field Squadron, R.E., Aldershot.
8th (Railway) Company, R.E., Longmoor Camp.
4th Army Co-operation Squadron, R.A.F., South Farnborough.

As a result of this combined exercise certain points emerged, and a short description of events may prove of interest.

2. A sketch map of the area is given. The 8th (Railway) Company, R.E., were responsible for operating and maintaining the W.I.M. Railway, Bordon–Whitehill–Longmoor Camp–Liss Forest, with a branch up to Weavers Down. This unit was " billeted " at Longmoor Camp.

The operations fell into three main heads :—

(*a*) *6th July*, 8.00 *hours till finished* (*about* 16.00 *hours*).

Relaying of half-mile track near Whitehill by 8th (Railway) Company, R.E., during which they were attacked by No. 4 Army Co-operation Squadron from the air with bombs (flour bags) and machine-gun fire.

The work itself consisted of substituting new 75 lb. F.F. rail and new sleepers for old 60 lb. F.F. rail and old sleepers in the W.I.M. Railway main line. This calls for no further comment.

(*b*) *Night of 6th/7th July.*

Raid on the W.I.M Railway and demolitions by 1st Field Squadron, R.E.

(*c*) *7th July*, 7.00 *hours till finished.*

Repair by 8th (Railway) Company, R.E., of damage to railway, as soon as the area had been reported clear of the enemy (1st Field Squadron) by aeroplane. Later in the day the aeroplanes " changed sides " and again attacked the railway troops while carrying out repairs

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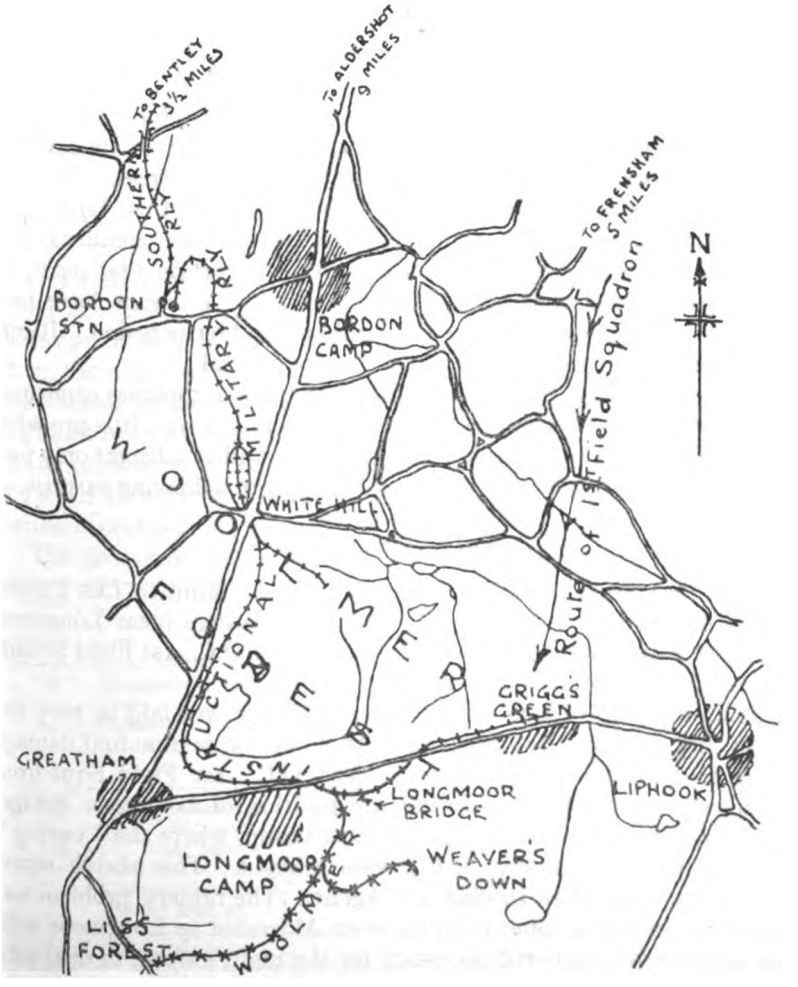
ATTACK ON RAILWAY TROOPS BY AEROPLANE, 6TH JULY.

3. The site where track re-laying was in progress was Whitehill railway cutting. This cutting is about 300 yards long, some 20 feet deep, and with high fir trees growing up to the edge of the cutting on both sides of the line. At the lower end of this cutting the main road passes over the railway by a bridge, which is almost a short tunnel.

THE WOOLMER INSTRUCTIONAL MILITARY RAILWAY & BRANCHES.



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The locality is " blind " and entirely favourable to surprise attack by aeroplane.

The first attack (6 aeroplanes) occurred at 10 a.m. and was a distinct success for No. 4 Army Co-operation Squadron. The aeroplanes approached low down over the forest, and at right angles to the railway. They were unseen and unheard till within a few seconds of their starting to drop bombs. The surprise was practically complete. Of 46 men working in the cutting, 50% were adjudged casualties from bombs alone in the first few seconds. Any man within five yards of a flour-bag bomb was counted as a casualty. Many men were caught working too far away from their rifles; others crowded under Whitehill Bridge. Three direct hits on the bridge itself, and the several bombs which fell into the cutting, immediately each side of the bridge, would probably have made casualties of most of the men sheltering there.

4. Three more aeroplane attacks were made later in the day. There was no further surprise, however, mainly owing to look-out men being now posted in the tops of two or three high fir trees. The two A.A. Lewis guns were better sited. They could see their targets for a longer period of time and in more favourable circumstances. Individual rifle fire was also better, and it is certain that on these last three occasions the aeroplanes would by no means have had matters all their own way, as they did on the first occasion. Blank ammunition was used by the troops on the ground.

In view of the extremely slow speed of these aeroplanes compared with those from which attack may be expected in war, it is probable that approach at right angles to the railway and at a height only just above the forest was the only possible means of achieving surprise.

THE NIGHT RAID.

5. The section of railway from Longmoor Camp to Liss Forest, the Weavers Down Branch and Longmoor Bridge (near Longmoor Railway Yard), were placed at the disposal of O.C., 1st Field Squadron, R.E., for demolition purposes.

Practically all of this three miles of railway was laid in very old 60-lb. rail and very old sleepers, so that the value of actual damage done to material was not great. The O.C., 1st Field Squadron, received a rough sketch, showing the position of Longmoor Bridge, Weavers Down Junction and Longmoor Camp, where the " enemy " (8th (Railway) Company, R.E.) were billeted. This sketch represented the work of an Intelligence Agent. The raiders' problem was therefore, to march some 16 miles from Aldershot to Longmoor with the explosives considered necessary for the night's work, to deal with enemy patrols along the railway if any were met, not to attract the attention of the enemy's main force in the camp (which is about 500 yards away from the railway), to cause maximum damage to the railway in the time available during darkness, and to get away back

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to Aldershot before the enemy investigated as a result of the explosions.

6. No previous reconnaissance of the area was allowed. The railway and the country generally was entirely unknown to the raiders until they reached it after dark on the night in question. The conditions and the whole "atmosphere" in which the men worked were thus probably as near the real thing as can be arranged in peace-time. Actually no 8th (Railway) Company patrols were on the railway, as the risk of casualties occurring in the dark owing to actual fighting developing, or to exploding charges, was considered too great. Their inclusion in the scheme had, however, the desired effect on the 1st Field Squadron personnel. The danger area was protected by a ring of sentries. These men, together with sentries in the camp itself, had orders to report all lights and noises noticed by them during the night, before the series of explosions later informed the whole neighbourhood of what was happening.

Time Table of Raid.

7. An assembly point was chosen by the raiders from the map. At this point limbers were unpacked and stores transferred to pack-horses and the men. This assembly point varied from 1½ to 2½ miles from any point on the railway. This distance was generally considered excessive by most critics, as the men were heavily laden, and from there onwards valuable time was occupied in reaching the railway across unknown country in the dark. The assembly point was 14 miles from Aldershot. This distance occupied 2½ hours, of which 20 minutes were wasted as a result of trying the inevitable short cut by night through unknown forest country, without a local guide and without previous reconnaissance by daylight.

The distances and actual time-table were as follows :—

From Start, miles.	Detail.	Troops.		
		1st.	2nd.	H.Q.
0	Rendezvous (near Aldershot) dep.	9.00 p.m.	9.00 p.m.	9.00 p.m.
14	Assembly Point (Griggs Green) ... ... arr.	11.30 p.m.	11.30 p.m.	11.30 p.m.
	dep.	12.10 a.m.	12.15 a.m.	12.10 a.m.
15½ to 16½	Started work on Railway :			
	First party	01.00 a.m.	02.00 a.m.	01.15 a.m.
	Last party	01.45 a.m.	02.15 a.m.	01.45 a.m.
	Charges fired at	03.05	03.05	03.05
	Bridge fired at	03.15	—	—
About 18	Assembly Point :			
	Arrival (on return journey)	04.00	04.00	04.00
	Departure, ditto	04.30	04.30	04.30
About 32	Arrival at Rendezvous (Aldershot)	06.45	06.45	06.45

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The total distance covered by the Field Squadron was thus 32 miles, of which 28 miles were by road and from 3 to 5 miles (according to the troops concerned) were across country, coming up to and away from the railway.

TASKS PERFORMED.

8. The distribution of tasks to the three Troops was as follows :—

Party No.	N.C.O.s	Men	Task	No. of charges	Total gun-cotton	No. of failures	Fired by
				1st Troop (2 *Officers*)	lb.		
1	2	5	Wooden trestle bridge ...	6 (with 8 detonators)	112	3(A)	Electricity
2	1	5	Points and track ...	18	27	5	Safety Fuze
3	1	2	Small bridge of steel rails ...	2	56	1	Ditto
4	2	9	Track and small mine	8	58	—	Ditto
				2nd Troop (2 *Officers*)			
5	1	8	Track and points	38	70	10	Ditto
6	1	5		6	28	2	Ditto
7	2	9		12	54	4	Ditto
				H.Q. Troop (2 *Officers*)			
8	1	4	Mines ...	1	29(B)	—	Ditto
				1	28		Ditto
9	1	5	Mines ...	1	40	—	Ditto
				1	28		Ditto
10	1	4	Mine ...	1	60	1(C)	Ditto
			Track ...	9	20	2	
Grand Total	13	56	—	104	612	28	—

Notes.—(A) Three charges misfired entirely, and others failed to explode the complete charge—*see* para. 15 later.

(B) The only charge of ammonal, all other charges were gun-cotton.

(C) For safety this mine was fired later by daylight.

The raiders had no knowledge of the best points to attack, other than the bridge.

The demolitions in all thus occupied about 170 men-hours of work actually on the site.

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Results on the Track.

9. A consideration of the above Table brings out certain points. The number of charges which failed to explode was 24% of the total; of those charges actually cutting rails, the failures were 30%. This proportion at first sight seems high, but is to be expected in the conditions. Most failures were due to fuzes not being properly lighted. This is easy to understand because of darkness, no lamps being used, and the men being hurried by the fact that they had just lighted another fuze only a few yards away. The charges for rail cutting, turnouts, and culverts, and the resulting damage, are shown in various photographs at the end of this article. It should be noted that the rail was 60 lb. and had been under traffic for some 20 to 30 years. As a result the rail was more brittle than the average, and the photographs show that pieces were blown out clean with extremely little bending of the rail. Generally speaking, a single slab of gun-cotton blew a hole in the web without damaging the head or flange of rail, which was therefore still usable at slow speeds. Two slabs were sufficient at rail joints for 60-lb. rail; but three are required for 75-lb. rail joints.

The Mines.

10. The illustrations show the mine craters photographed from the air, and from ground level. These were all in an unconsolidated sand embankment about 12 feet high.

The charges and results were as follows, the mines being numbered from the Longmoor end, *i.e.*, from the right of the aeroplane photographs:—

Mine Number.	Charge.	Resulting Crater.	
		Diameter.	Depth.
1	29 lb. Ammonal	28 ft.	7 ft.
2	28 lb. Guncotton	28 ft.	6 ft.
3	40 lb. ,, ...	20 ft.	7 ft.
4	28 lb. ,, ...	18 ft.	7 ft.
5	60 lb. ,, ...	Misfire	

It will be noticed that ammonal had considerably more effect than gun-cotton. All the above mines were in trenches, 6 ft. long by 2 ft. wide by 6 ft. deep, dug without removing sleepers. Sandbags were used for tamping. Except for No. 5, the mines were fixed in pairs.

Each charge had two separate fuzes, one with 8 feet of safety fuze, the other with 3 feet of safety fuze, to *cordeau détonant* connecting the mines in pairs. Mine No. 5 failed because the safety fuze had gone out after burning a few inches. The alternative fuze had never been lighted.

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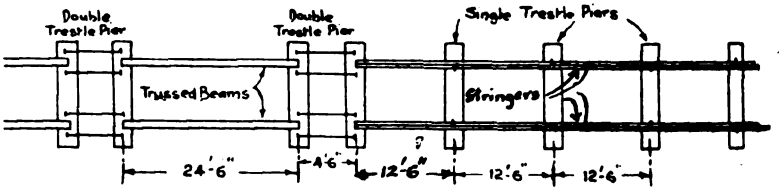
THE BRIDGE.

11. The bridge was a timber one across dry land and of 12 in. by 12 in. trestles on concrete foundations, with two timber stringers under each rail. The single trestles were of normal construction, supporting spans of 12 ft. 6 in. The double trestles were of similar construction, placed at 4 ft. 6 in. centres. These double-trestle piers supported trussed spans of 24 ft. 6 in. The whole bridge was extremely solidly constructed, well braced, and capable of carrying the heaviest locomotives. The two stringers under each rail were continuous over two spans, but joints were staggered thus :—



A bridge of this sort is extremely difficult to bring down properly, particularly as regards untrussed spans, owing to the short spans and the fact that the railway track *or* bracing *or* stringers are each sufficient in themselves to keep the whole structure up unless *several* consecutive piers are cut completely. This, in fact, was exactly what occurred, as will be seen.

12. Certain restrictions were placed on demolition :—

(*a*) The abutments were sleeper cribs filled with ballast. Attacking them with explosives was forbidden because of the danger from flying stones. The bridge was within 60 yards of a main road and 200 yards of houses.

(*b*) The concrete foundations to the trestles were not allowed to be attacked for similar reasons.

(*c*) Burning the bridge was not allowed. Fire is usually the most effective way of dealing with timber structures, providing the fire has time to do its work before the enemy can put it out.

13. The bridge had not been reconnoitred by day and reconnaissance in complete darkness without lights apparently did not elicit the fact that stringers were continuous over two spans. The raiders decided to cut by explosive one single-trestle pier, and one double-trestle pier. These piers were situated four spans apart. This was a mistake in the circumstances—not to attack neighbouring trestles. Each trestle was to be cut at its base and close to the bottom sill. Even if every vertical and raker of two or three trestles

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had been cut, the bridge would probably only have dropped a little before the shortened trestles touched the sill or the ground, and stopped further settlement of the superstructure. This permits jacking up for repair and represents the second mistake. The legs should have been cut about half-way up so as to give a maximum drop before support to the structure could occur. In the case of the single trestle, the fact that the stringers were continuous over two spans entirely prevented any settlement whatever of the superstructure. The trestles themselves were about 14 ft. to 16 ft. high. To fix charges half-way up would thus have been more awkward than fixing them at the foot.

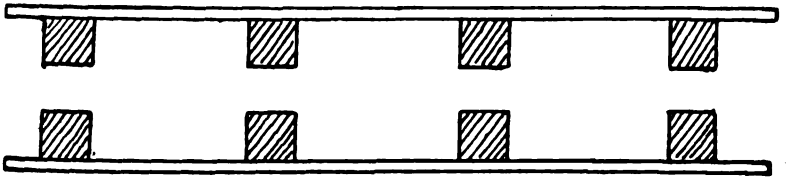
14. The fixing of charges on the bridge was as follows, the method adopted being due partly to a shortage of primers.

Single-Trestle Pier.

Plan.

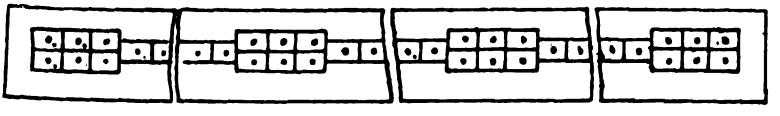
Six slabs of gun-cotton were arranged, as shown, against each 12 in. by 12 in. This occupied 30 minutes.

Double-Trestle Pier.



Each trestle of the double pier had a continuous charge of 44 slabs, arranged so that 6 slabs came opposite each 12 in. by 12 in. thus :—

Side View of Long Charges on Double-Trestle Piers.



The board to which this continuous charge was fixed was 12 in. by 3 in., cut from the cross bracing of the bridge. The double-trestle pier took one and three-quarter hours to prepare.

One detonator was fixed in each of the four charges on the single trestle, and two detonators in each of the long charges on boards on the double trestle. There were, therefore, eight detonators, and these were connected up in series and fired electrically.

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RESULTS OF DEMOLITION ON BRIDGE.

15. The results are clearly shown in the photographs. It will be noticed in the single-trestle pier only one raker and the sill were damaged, while in the double-trestle pier four out of the eight legs only were cut.

It appears that three detonators on the single pier and possibly two on the double-trestle pier failed, and these long charges failed to explode completely. Two detonators were recovered undamaged, and sent for test. As a result of investigation later, it was discovered that this type of detonator was obsolescent and faulty, and had been issued by mistake.

It has been suggested that it was a mistake to try and fire that number of charges simultaneously, and that it would have been preferable to fire the charges in small groups. This reduces the risk of misfires, but, when time presses, the obvious danger in this proposal is that, as no charges can be fired till the signal, all charges will usually have to be placed ready *in situ* and the detonation of the first group may possibly displace the second. In this particular case, the charges had to be close, and it is considered that simultaneous firing was the only possibility. Eight detonators is well within the capabilities of the exploder.

The essential point is, therefore, to ensure that the detonators are not faulty. They can all be tested for continuity before use, and a proportion from each tin could be tested for sensitiveness by firing in groups. It is considered that the fault was in this case due to variable sensitiveness in the detonators.

Each troop of a field squadron carries only one exploder and a limited amount of cable, and this further restricts the possibilities of group firing.

It is interesting to note that, shortly after the charges were fired, some empty railway trucks, weighing six tons each, were pushed on to the damaged section of the bridge in order to cause it to collapse. These trucks had no effect, and caused no visible settlement even.

OTHER POINTS OF THE RAID.

16. All the charges were timed to be ready for firing at 3 a.m. The raiders were, however, spread out over three miles, and the actual time for starting to fire the charges was given by firing a Very light. Further secrecy was then impossible, and each troop of the Field Squadron fired its own charges as quickly as possible and fell back on the Assembly Point, being guided back by further Very lights. From paragraph 7 above, it will be noted that the charges at the bridge were not ready when the Very light went up, and the bridge was not fired till ten minutes later. This delay

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might have proved serious in war, being so near the enemy's camp.

Great credit was due to the raiders for the extremely quiet manner in which they reached the railway and for the way they worked on the railway without attracting attention.

The night was dark and dry. Reaching the objective and feeling for enemy patrols was particularly well done. Many senior officers witnessed this. The Inspector of Royal Engineers was present, and at one period had been standing still for several minutes on the high embankment near the bridge, watching and listening. Other watchers at the foot of the bank presently saw against the sky-line three shadows closing in on what they must have taken to be an 8th Company patrol. These "shadows" got within five yards of their man and were preparing for the final rush, before the General saw or heard them and spoke—very much to the relief of the watchers at the foot of the bank!

The work of preparing the charges was also done extremely quietly. Slight noises and three flashlights for a few seconds were reported by the protecting ring of 8th Company sentries, between mid-night and 3 a.m. These sentries were on a hill overlooking the railway, where no enemy troops, however, would normally have been likely to be.

No lights and only one small noise of metal to metal was reported by sentries in the camp itself. These men were specially ordered to look and listen. The raiders may thus be considered to have done their work without having aroused enemy suspicions as to anything unusual taking place, until the first Very light gave the signal for a series of explosions.

A small mine in the Weavers Down Line (not one of those mentioned above), went up some 45 minutes after the fuze had been lighted and the raiders had all gone. The cause of the delay action effect is not known. The delay was, however, so great that it nearly caused an accident. The 8th (Railway) Company sentries protecting the danger area had been called in by then by locomotive whistle, and two of these men coming in across country were uncomfortably close when this mine exploded.

Aeroplane Reports of Raid.

17. At dawn, on 7th July, three aeroplanes of No. 4 Co-operation Squadron, R.A.F., flew over the area, with a view to reporting :—

(*a*) What damage could be seen from the air, and

(*b*) if the area was clear of the raiders, and their line of retirement.

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With regard to the former, although the aeroplanes came down to about 300 feet, they could see no damage other than the mine craters. The bridge was stated to be undamaged.

The track was reported to have been "removed" in three places, one of which proved to be the small rail bridge, of which photographs are given. Map references of the other two points were given, but no damage had been done there. It looks, therefore, as if aeroplanes cannot see damage to railways, except where it covers a large area —such as a mine crater or a thorough bridge demolition.

Three 8th Company officers were kindly allowed to go up in the aeroplanes, but rejoined their unit before 7.00 hours, *i.e.*, when 8th Company started repairs to the railway.

A dropping station for aeroplane messages was manned by 8th Company personnel; and at 5.13 hours a message was received to the effect that the area was clear of raiders who were retiring on Frensham.

At about 7.00 hours (*i.e.*, when there was sufficient daylight) another aeroplane took a series of photographs of the railway. One showing mine craters is reproduced; the remainder showed no damage. These photographs were taken by air to South Farnborough for developing, and prints were dropped at Longmoor within two hours.

REPAIRS BY 8TH (RAILWAY) COMPANY, R.E.

18. Owing to the absence of their officers, who were in the aeroplanes, the 8th Company did not parade till 7.00 hours. Although Longmoor Bridge is not situated on the direct Longmoor-Liss Forest line, it was assumed to be so for purposes of this scheme, and had to be repaired before track material could be brought up by rail for repairs further up the line.

The bridge was repaired, and a 53-ton locomotive passed over it within five hours, including loading and delivering material. This time includes delays due to three attacks by aeroplanes, and could undoubtedly have been lessened considerably. In the circumstances there was no need for it, as the men were mostly working further up the line. Repairs consisted essentially of cutting off horizontally the jagged ends of the damaged legs and packing up with horizontal baulks of timber.

A photograph shows the locomotive standing on the bridge. Bracing was not replaced on the piers as repaired, and this can be seen from the photograph.

The repair to the damaged track further along the line calls for little comment, and was quickly executed. The whole of the damage done by the raiders, including Longmoor Bridge, was repaired by 60 men in 22 hours, in spite of aeroplane attacks. This gives about

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1,320 men-hours or about eight times the number it took to cause the destruction. The nine craters were in an embankment, with a wide formation, *i.e.*, an excess of earth, and the craters were thus filled by borrowing from the embankment itself. On a really narrow bank this might not have been possible. The volume required was sufficient to cause considerable delay if it had had to be transported to the site—and this might also have involved filling up one crater only at a time.

While the 8th Company were carrying out repairs, four more attacks were made on them by aeroplanes. This, however, calls for no further comment, except that the time lost (in all about two hours) is included in the figures quoted above.

CONCLUSIONS.

19. Some of the important conclusions on various points have already been mentioned. Other points worth mention are as follows, and were brought up at a conference held afterwards between the various officers concerned :—

(*a*) For a given expenditure of time and explosive, the delay caused by the destruction of a bridge, or other major work, usually greatly exceeds that due to destruction of track. For this reason, a bridge is more likely to be protected by sentries or visiting patrols and will, therefore, be more difficult of access. Nevertheless, it is generally worth the effort of demolition.

(*b*) If a " key " point (such as a bridge) exists on the section of railway, and is to be attacked, every effort must be concentrated on it to the exclusion of all else, if necessary. In other words, the dictum of concentrating on the decisive point, and to the exclusion of unimportant side-shows, still holds good—as it always does, in every walk of life, and not only in things military.

(*c*) While men are working at an important point, such as a bridge, which is likely to have a visit from enemy patrols during the night, they should be protected by outlying pickets who can deal quietly with enemy patrols approaching *and before their suspicions are aroused*. This is doubly important when working within 500 yards of a considerable enemy force, as in this case.

(*d*) In a raid of this sort, the time of firing all charges should have been dependent on the decisive point—the bridge—being ready. The fact that this was late would certainly have caused trouble in war, and was a source of danger to the raiders.

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(*e*) Attacking rails at alternate joints so that every rail is damaged (and particularly points and crossings) may have additional value to that of delay only, if it is known that the enemy is short of track material, *e.g.*, the Turks during the last War. The General Staff will presumably give a pointer as to this.

(*f*) The effect of various charges on rail cutting should be tried out prior to a raid. It depends on weight of rail, type of fishplate, etc. If this is not done, there is a risk of insufficient damage being done or at least a great waste of explosive.

(*g*) The number of charges that one man can be expected to fire should be kept low. It should never exceed four, while two or three is better. The lower it is, the less should be the percentage of failures.

Besides the Inspector of Royal Engineers, the Chief Engineer Aldershot Command, the Asst. Director of Transportation, War Office, several other senior officers, who were present at night or saw the damage next day, considered the raid was a real success in all respects, except as regards the bridge demolition. Experience in South Africa, 1899–1902, and in every theatre of the Great War, 1914–1918, has invariably shown that a well-built timber bridge of this sort is almost impossible to demolish thoroughly by explosives in quick time, particularly under the conditions in which this raid was carried out. Timber and reinforced concrete structures are in this respect a very great deal more difficult to bring down completely than steel or masonry structures and require more thorough reconnaissance and thought.

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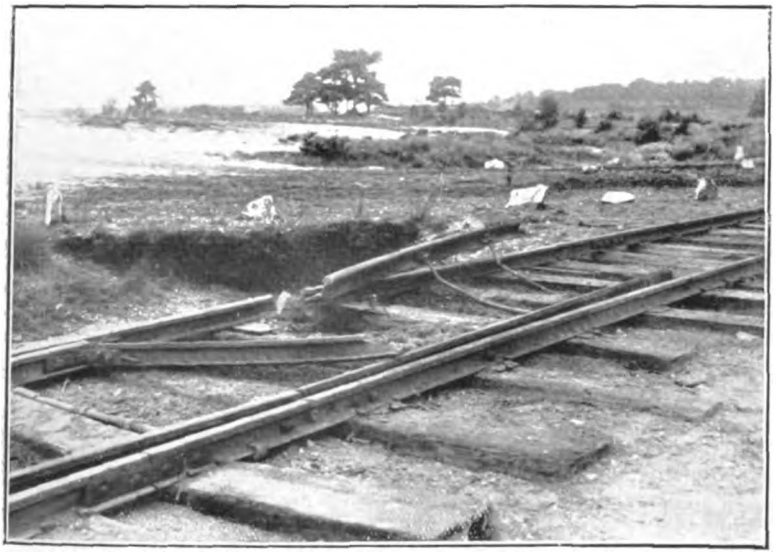
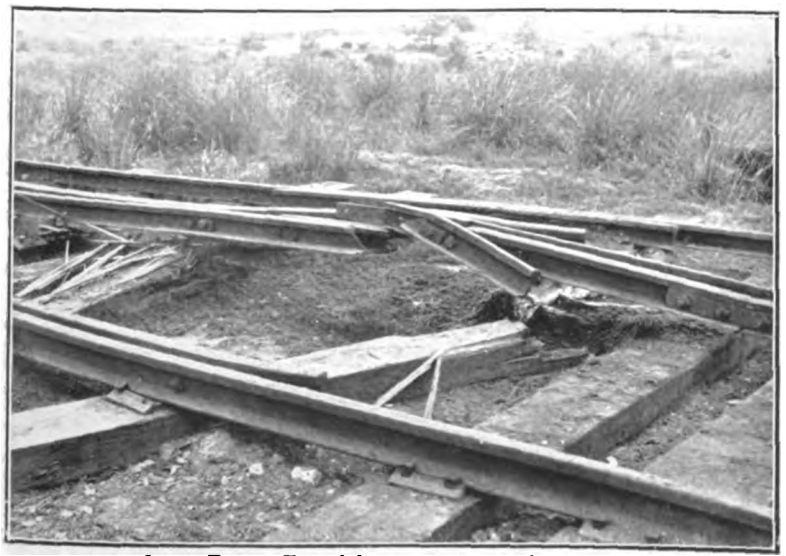
A RAILWAY RAID.

A Side-Show on the Frontier of the Aldershot Command.



60-lb. Rail.—Six slabs gun-cotton at the crossing.



60-lb. Rail.—Two slabs gun-cotton at the switches.

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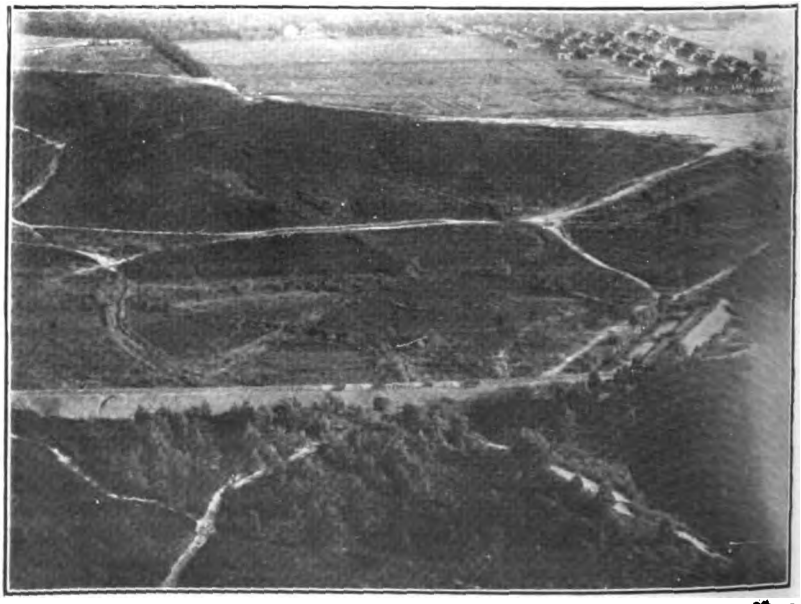
The effect of two 5-lb. charges of gun-cotton in a culvert in a 2-ft. bank. Only one charge exploded.



AEROPLANE PHOTOGRAPH OF MINE CRATERS.—No. 1 (ammonal) is on the right. No. 5 (to the left) misfired. In the background, the enemy camp at Longmoor. The embankment is 12 ft. high.

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No. 1 CRATER.—29-lb. ammonal. Diameter, 28 ft. Depth, 7 ft. Craters Nos. 2, 3 and 4 are in background.

DAMAGE TO THE SINGLE TRESTLE.—Right-hand, raker and bottom sill damaged. Left-hand, raker and both verticals undamaged.

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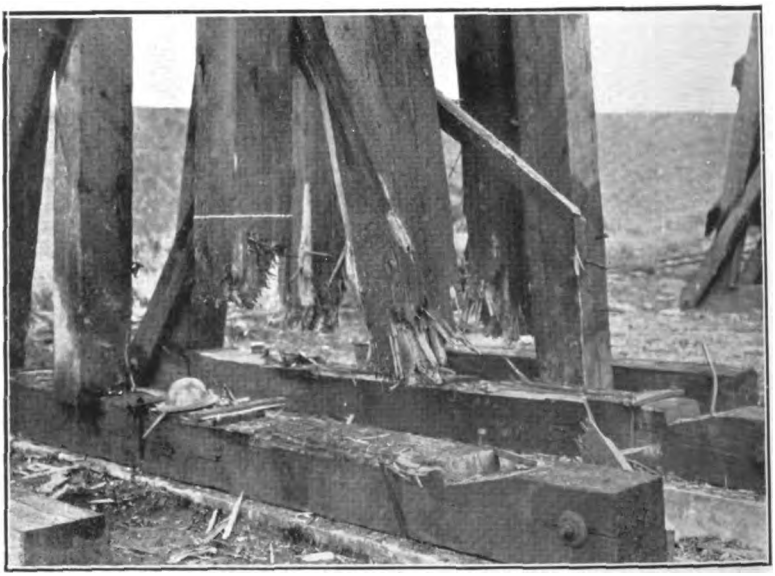
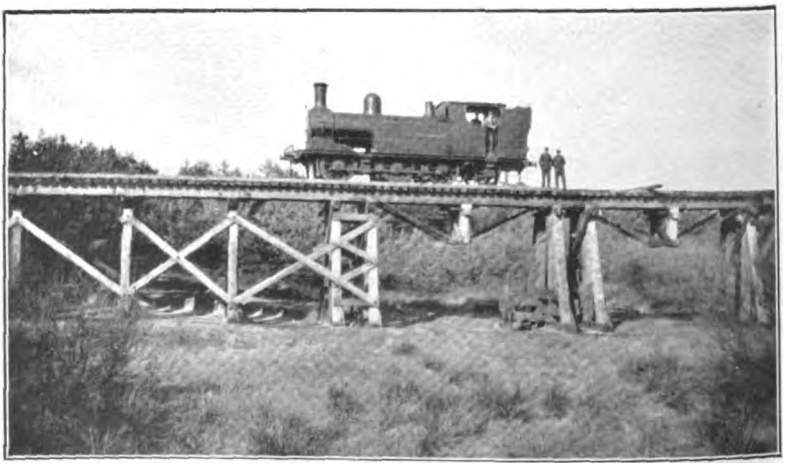


DAMAGE TO THE DOUBLE TRESTLE.—Both left-hand rakers, and both bottom sills are intact. Left-hand, near vertical, moved 3 inches, otherwise intact. Right-hand, far raker blown off its seating and hanging from superstructure, otherwise undamaged. Three verticals and one raker only were cut, out of the eight timbers concerned.



THE BRIDGE.—After repair, with 53-ton locomotive. The single trestle is on the extreme left of photograph. The double trestle is between the two trussed spans. Repairs are visible near the man on the ground

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DISTRIBUTION OF LOAD TO ROADBEARERS IN MILITARY BRIDGES.

By CAPTAIN H. A. BAKER, M.C., R.E.

IN *The R.E. Journal* for September, 1926,* an endeavour was made to show by a theoretical treatment that a vehicle crossing a bridge, consisting of several roadbearers and timber decking, produces stresses in the roadbearers considerably greater than that obtained by merely dividing the total load by the number of roadbearers. It was shown that the subject was, theoretically, considerably involved, but certain figures for the maximum percentage of axle load which could come on to one roadbearer, with a definite thickness of decking, were deduced from the theory.

It has now been possible to test these theoretical results in practice, and the attached Tables show the results obtained from the various tests carried out, and how they compare with theory and previous assumptions.

The tests were carried out with a 3-ton lorry on a 10-ft. roadway, with the lorry wheels right against one kerb.

The deflections of the roadbearers or girders were taken and the maximum percentage of live load on one bearer calculated. The results shown are the average of several tests. The decking was changed between tests, and all precautions were taken to get good average results.

The diagram shows how the results obtained from the test can be used to determine the loading conditions on the decking, and also shows the full distribution of live load to roadbearers for one experiment.

The results are perhaps interesting, as they bear out the theoretical treatment very well in the one case where the full calculation was done, and show the necessity for considering this question carefully when designing a bridge.

* "The Relation between Decking and Roadbearers in Military Bridges."

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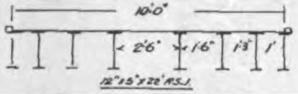
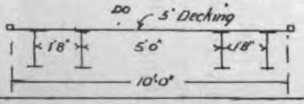
TABLE SHOWING RESULTS OF TESTS TO FIND DISTRIBUTION OF LIVE LOAD TO ROADBEARERS ON A BRIDGE

TEST No	ARRANGEMENT OF ROADBEARERS & DECKING.	LOADING CONDITIONS	MAX. PERCENTAGE OF LIVE LOAD ON ONE R.S.J. OR GIRDER		REMARKS
			FROM EXPERIMENT	PREVIOUSLY CALCULATED OR ASSUMED	
1		MK. V TANK (30 Tons) Central	13·72	8·5 Assumed	Usually assumed to be evenly distributed. Not calculated. Tank can only be central owing to width.
2	DO	3 TON LORRY CENTRAL	17·4	NOT CONSIDERED	
3	DO	3 TON LORRY AGAINST one Kerb	23·2	18. assumed from calculations on other bridges	The difference is probably accounted for partly by the inaccuracies obtained from reading small deflections and to the fact that the R.S.J. were rather old. The original figure of 18 was only assumed as calculation is too involved.
4	30' MK II Bridge as below	MK. V Tank (central)	28·4.	25 assumed	
5	DO	3 Ton Lorry (Central)	27·3	—	Not previously considered as not being the worse case.
6		3 Ton lorry against one Kerb	40·35.	41 Calculated	This was the actual calculation carried out previously & which it was desired to test.
7	Box Girder Bridge 4' Decking } Two Girder. -do- Three -do- Four	3 Ton Lorry against one Kerb -do- -do	64·7 42·6 34·58	Assumed 50 " 37 " 33	Tanks were tested on 4 Girder Bridge and gave 25·97% They can thus be treated as evenly distributed for practical purposes on 4 Girder Bridge on a 3 Girder Bridge% for a Tank would probably be about the same as for the lorry against one Kerb. This could not be tested.

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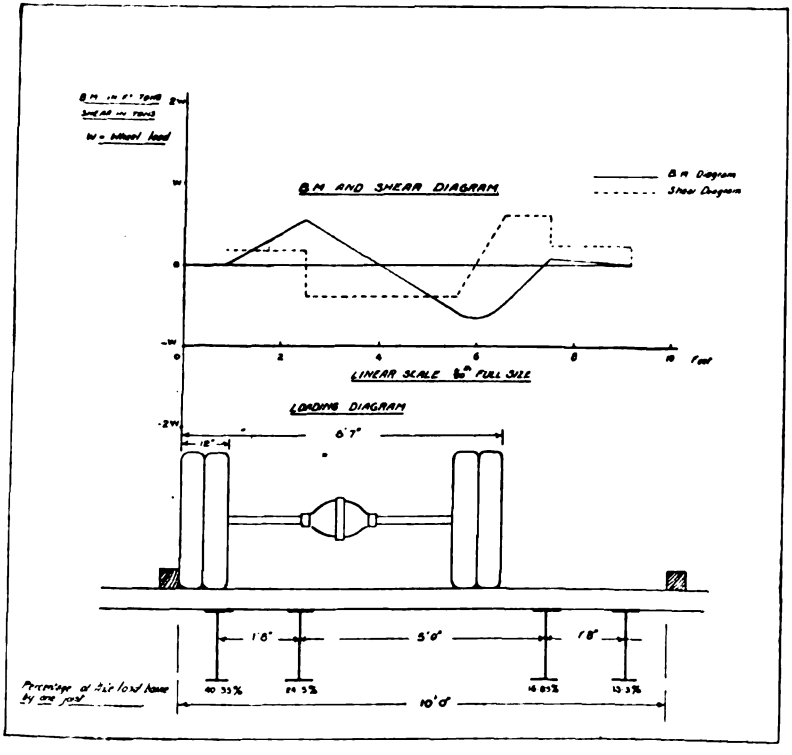
EXPERIMENTAL DETERMINATION OF DISTRIBUTION OF LOAD IN R.S.J. BRIDGE.

GRAPHICAL REPRESENTATION.



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THE BRUSTON PATENT AUTO-PNEUMATIC SYSTEM OF WATER SUPPLY.

By LIEUT. A. D. CAMPBELL, M.C., R.E.

AN installation of this type was inspected recently at Princes Risborough (Bucks) where it had worked, with apparent satisfaction, for about eighteen months.

The main features of the system are as follows :—

(*a*) The necessity for reservoirs or water-towers is obviated by the installation of a pair of steel cylinders acting as pneumatic tanks on the delivery-pipes from the pumps.

(*b*) The necessity for full-time attendance at the pump-house is obviated by automatic switch-board control, actuated by the air-pressure recorded in the pneumatic cylinder.

PROCESS

Consider a case where a head of 250 feet is required at the delivery side of the pumps. Water is pumped into the steel cylinders, compressing the air content until the pressure meter on the switch-board registers say 110 lb. to the sq. in.

At this juncture, the pointer of the meter makes contact with one of two adjustable terminals, completing a circuit, which shuts down the pump.

As water is drawn off by the consumers, the air expands in the cylinders, reducing the pressure on the water until the pointer at, say, 100 lb. per sq. in., makes contact with the second terminal, and the pump is automatically restarted.

Where two or more pump units are installed, a separate pressure-gauge is connected to each one, the upper and lower terminals being adjusted so that they are brought successively into action, to cope with large demands, and shut down in turn again as the pressure mounts.

PLANT.

The plant is composed as follows :—

Pumping units.
Pneumatic tanks or cylinders.
Switchboard and connections.
Starting batteries
Air compressors.

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Pumping units.—At Princes Risborough there were two units, consisting of two three-throw pumps, capacity 3,000 g.p.h. each. No. 1 pump is driven by a two-cylinder 10 H.P. " Lister " petrol-engine, coupled to an electric starter and generator with a 110-volt set of starting batteries.

On starting, the generator acts as a motor, rotating the engine with the exhaust-valves kept open by a solenoid starter. When sufficient speed is attained, the valves are released, and a centrifugal clutch brings the pumps into action, at the same time cutting out the motor, which returns to its normal function of a generator.

No. 2 pump is driven by a three-phase motor, current being supplied at 380 volts from the local power station.

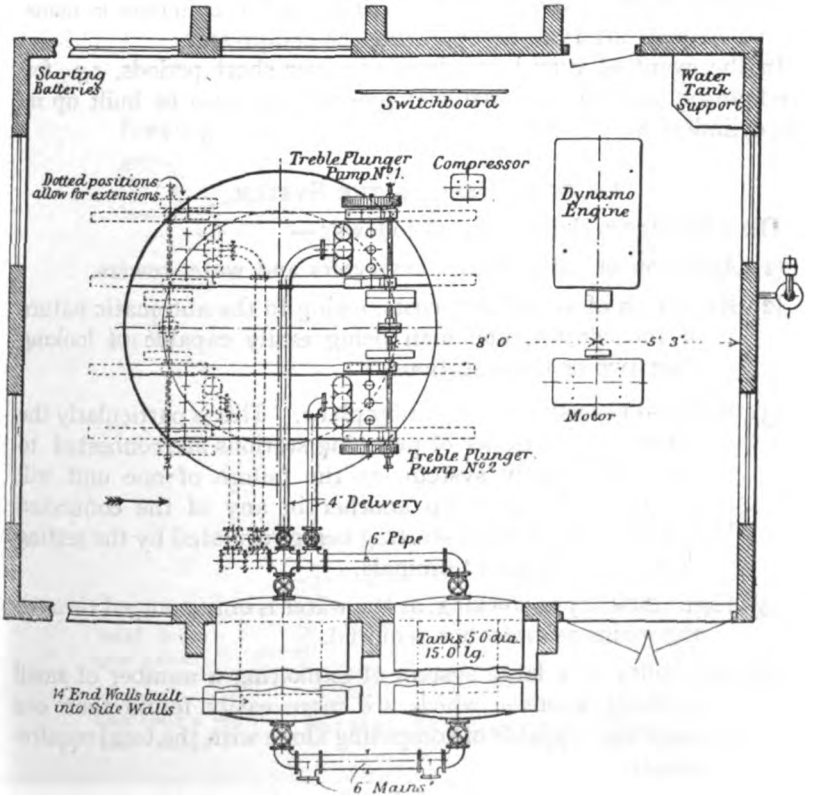

FIG. 1.

The plant is so arranged that, in the event of a breakdown, either pump can be driven by either prime-mover, and further, if the petrol supply fails during the time No. 1 pump is running (or the electric current for No. 2 pump), the other unit is automatically started up through the functioning of a form of governor control on the switchboard.

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Pneumatic tanks.—The dimensions of these obviously depend upon the nature and quantity of the supply required. As a rough guide, two thirds of their volume should give a water content equal to half-an-hour's output from the pumps at the requisite air-pressure. They are so connected to the delivery-pipes that each pump can deliver into either or both tanks, and are connected at the further end direct to the delivery-main.

Switchboard.—This is covered by a patent by G. C. Pillinger & Co. Its functions have been referred to above.

Starting batteries.—These are used for lighting the pumping station and for starting purposes, being recharged by the generator while the petrol-engine is in action.

Air-compressor.—Any leakage of air from the cylinders is made good at regular intervals by operating the compressor.

In the event of very large demands over short periods, *e.g.*, for fire-fighting purposes, an artificial pressure can also be built up in the cylinders by this means.

General Uses of the System.

The advantages claimed are as follows :—

(1) Abolition of rising mains, reservoirs and water-towers.

(2) Reduction of attendance costs, owing to the automatic nature of the control, one man being easily capable of looking after two or three stations.

(3) Reduced necessity for stand-by plant. This is particularly the case where a number of pumping stations are connected to the same supply system, as the failure of one unit will automatically start up another in any of the connected stations, the order of starting being regulated by the setting of the switchboard terminals.

(4) High efficiency in working, as the water is only pumped through the mains as and when required.

(5) Possibility in a large system of exploiting a number of small capacity sources, which are more easily found than one large one, capable of competing alone with the total requirements.

(6) Possibilities as a boosting plant, which may be fitted at any point in any supply system. This is particularly useful in cases where a small portion of the system is at a height appreciably in excess of the remainder (*see* Fig. 2). In normal supply systems the worst-placed tap is the controlling factor, but by installing a boosting unit to deal with the higher levels, the head in the remainder of the circuit can be correspondingly decreased.

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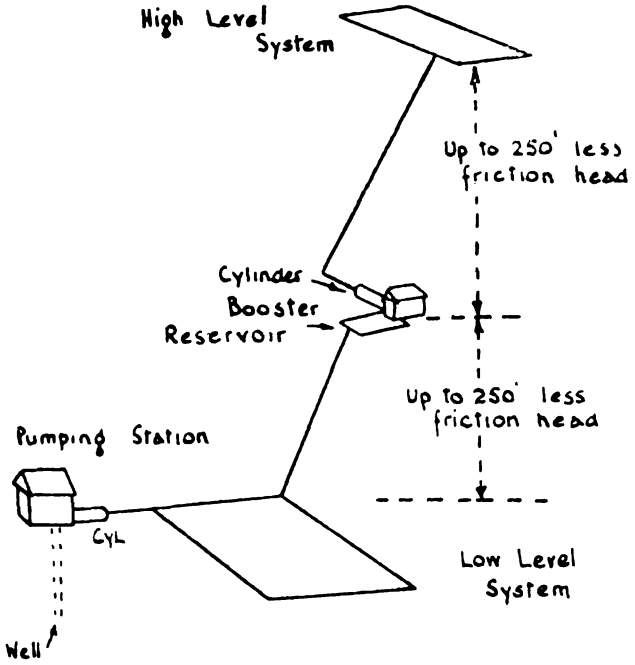
(7) General flexibility and possibilities for expansion.



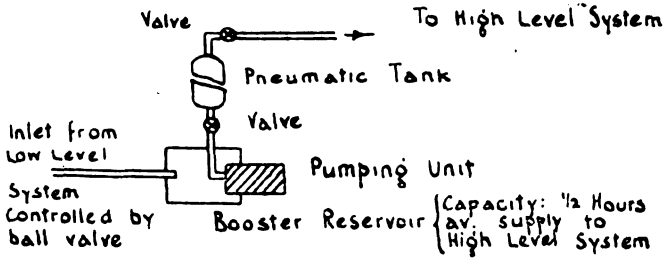


Diagram illustrating the uses of the "Bruston" System for Boosting.

FIG. 2.

(8) Economy. It is claimed, and the figures available tend to support the claim, that economies up to 40 per cent. of the cost of equivalent centralized installations can be obtained, by using this decentralized system.

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There would appear to be distinct possibilities in the system from the military point of view, *e.g.* :—

(1) *Peace.*—Small military communities with no civilian supply systems in the immediate vicinity. For numbers under two thousand, the saving in an installation of this type, in reservoirs and rising mains alone, would be proportionately high, without considering the reduction in attendant costs.

(2) *War.*—Bases and points on the L. of C. where the duration period is sufficiently long to justify a piped supply, and where no civilian systems can be adapted. In this connection, it should be noted that, for fire-fighting purposes, a considerable volume of water is available, for short periods, at a head sufficient to obviate the necessity for manuals or fire-engines.

CALCULATIONS.

Pumps.

(1) For purposes of standardization, it should be assumed that there are three sizes of pumping unit available in the capacities of 3,000, 6,000, and 10,000 g.p.h. respectively.

(2) Calculate, in the normal way, the quantity of water required per day in the summer months, *i.e.*, including watering of recreation grounds, etc.

(3) Reducing this figure to gallons per hour, select the standard unit next above it. It has been found in civilian practice that a unit rated to deliver 20 per cent. more than the average requirements is capable of dealing adequately with the fluctuations in demand throughout the 24 hours.

In military communities the enhanced regularity of routine would presumably entail a somewhat higher percentage, as demands for certain purposes, *e.g.*, ablutions, washing up, etc., are more highly concentrated at certain definite hours.

It is suggested, therefore, that a reasonable basis for calculating the capacity of the pumping unit, for a purely military system, is attained by assuming that the daily requirements are consumed in twelve hours, and allowing 20 per cent. excess capacity to cover the fluctuation between average and maximum rates of flow during this time. This is equivalent to saying that the capacity of the pumping units in gallons per hour should be 10 per cent. of the daily requirements.

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Thus, a daily consumption of 90,000 gallons would necessitate the installation of either :—

(1) One pumping unit of capacity 10,000 g.p.h.
(2) One " " " " 6,000 " } One " " " " 3,000 " }
(3) Three " " " " 3,000 "

The choice between these alternatives must be decided on the individual merits of each case, particularly on the possible advantages accruing from decentralization.

The following Table gives a very approximate idea of the relative prices :—

Gallons of water per hour.	Approximate Price with automatically-started internal-combustion engines.	Price with electric motors.
3,000	£1,900	£1,350
6,000	£2,200	£1,600
10,000	£3,000	£2,500

Stand-by plant.—There should be in every case a connection at some point between the fire-fighting and domestic supply systems. This connection can usually be most easily attained by having a common main from the pump-house, branching off later into separate ring mains for each supply system.

The advantages accruing from this process will be :—

(1) Reduction in size of stand-by plant.

(2) Greater facility for shutting down domestic supply in case of fire.

Assuming this to be the case, the plant required for each system of supply can be separately calculated, and it will normally be found, in the case of small communities, that the excess plant required for fire-fighting purposes, over that for domestic supply, will be amply sufficient to act as a stand-by plant for the latter.

The provision of stand-by plant for fire-fighting purposes, although eminently desirable, is not always economically possible, and may on occasion be dispensed with.

Cylinders.—There are normally two cylinders for each pumping station, of which two-thirds of the capacity is available for water storage at the standard head of pressure. This volume of water should be equivalent to half-an-hour's average supply in each cylinder.

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Where the domestic and fire-fighting supply systems are combined, the pressure head in the cylinders should be that required for fire-fighting purposes, the excess head in the domestic system being eliminated by smaller branches from the mains.

The limiting head recommended by the patentees of this system is 250 feet for each lift, although for new works special plant can be designed to suit the conditions of the site.

Mains, branches, etc.—As for normal distribution systems, the level of the hydraulic gradient at the pumping-station being fixed by the pressure head in the cylinders.

EXAMPLE.

Consider the case of a community for whom the maximum daily domestic supply is calculated to be 60,000-gallons. If the method, advanced above, of calculating the capacity of the pumping units, is accepted, one 6,000-gallon per hour unit would suffice for the domestic supply.

Fire-fighting supply.—Assuming the nature of the buildings concerned is such, that a supply of at least 240 gallons per minute is required, for periods up to half-an-hour at a time, the quantity of water required will be 7,200 gallons, to be delivered in 30 minutes.

This is supplied from two sources :—(*a*) the pneumatic tanks or cylinders and (*b*) the pumping units.

The total quantity available in the cylinders will be equivalent to half-an-hour's average supply each, or, in the case where two cylinders are installed, to 5,000 gallons.

Assume as a first approximation that at the end of half-an-hour's fire-fighting this storage can be reduced by one-quarter. The quantity of water available from the cylinders alone will be 1,250 gallons, leaving 5,950 gallons to be supplied by the pumping units in half-an-hour.

Two units will, therefore, have to be installed of at least 6,000 g.p.h. capacity each.

Working on this assumption, we have 6,000 gallons supplied, during the period required, by the pumps, and the storage in the cylinders depleted by a further 1,200 gallons, or 600 gallons per cylinder.

It must now be considered how this depletion will affect the pressure head.

Using the formulæ $\frac{PV}{T}$ = constant, and assuming that the temperature remains unchanged, we have

$$P_1V_1 = P_2V_2 ; \text{ or } P_1 = \frac{V_2}{V_1} \cdot P_2$$

for the air content of the cylinders.

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We know that one-third of the total cylinder volume contains air, and that the remaining two-thirds is equivalent in each case to approximately 2,500 gallons of water :—

$\therefore$ V_1 for each cylinder

$$= \frac{2500}{6{\cdot}25 \times 2} \text{ cub. ft. } = 200 \text{ cub. ft. of air.}$$

$$V_2 = 200 \text{ cub. ft.} + \frac{600}{6{\cdot}25} \text{ cub. ft.} = (200 + 96) \text{ cub. ft.} = 296 \text{ cub. ft.}$$

$$\therefore \qquad P_1 = \frac{296}{200} \cdot P_2 = 1{\cdot}48\ P_2.$$

P_2 must, when reckoned in feet head, be equal to the total of the following :—

(1) Difference in G.L. between hydrant and pump-house.
(2) Friction loss in the mains between these points.
(3) Head required at the hydrant for the building concerned, *e.g.* :—

three-storey building	..	100 ft.
two ,, ,,	..	80 ft.
one ,, ,,	..	60 ft.

The value of P_1 can then be calculated, and this figure will give the standard pressure head required in the pneumatic cylinders, which, as previously stated, should not normally exceed 250 feet per lift.

Sizes of plant required :—

(*a*) Two 6,000 g.p.h. units will, therefore, be installed, allowing a stand-by of 100 per cent. for the domestic supply, and adequate, apart from breakdowns, for fire-fighting purposes.

(*b*) Two pneumatic cylinders, each of approximately 600 cubic feet volume, will also be required.

As a point of interest it may be noted that, for the ordinary system of supply, a pumping unit of at least 3,200 g.p.h. would have to be installed in this case, with 100 per cent. stand-by, or two units of 3,200 g.p.h. minimum capacity each. As an offset, however, against the increased cost of the pumping plant, we have the elimination of a 180,000-gallon reservoir, with a rising main thereto, and possibly either staging for the reservoir or increased length in the supply mains from the reservoir to the ring

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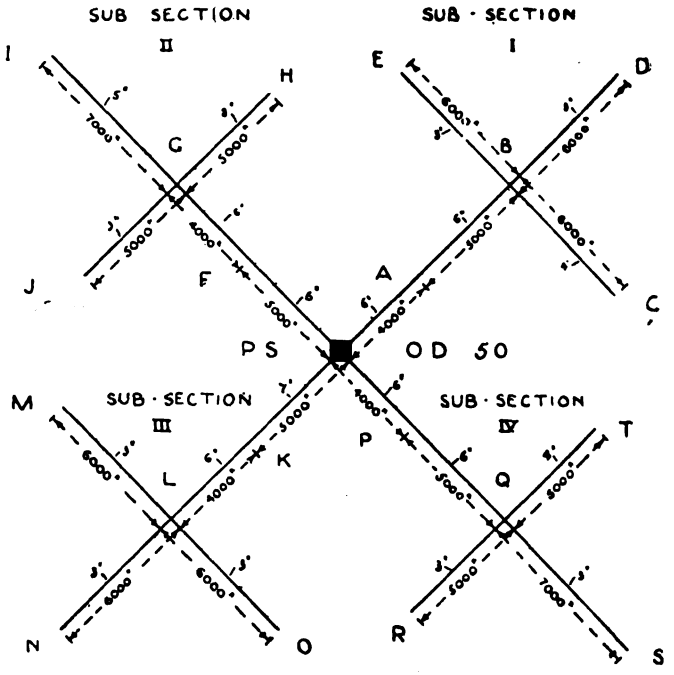
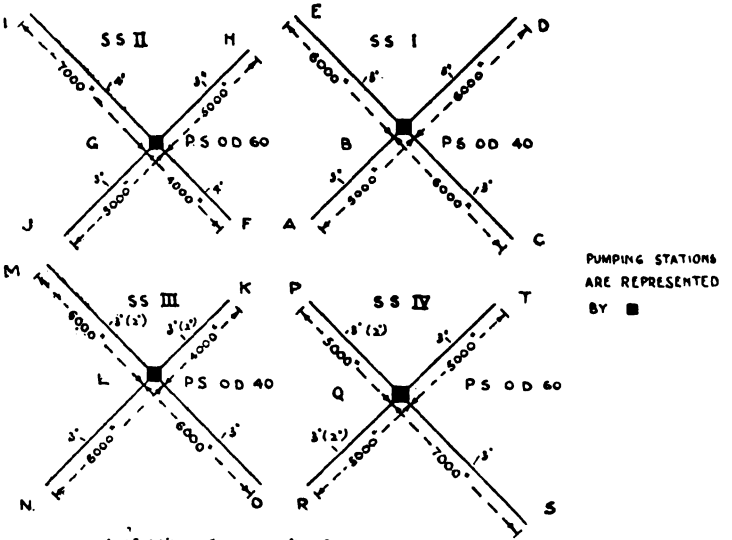
CENTRALISED



Area of 15 Miles Square with 20 Villages having an assumed Total Population of 16.600 supplied by one Central Pumping Station
Total Cost of Mains £ 65.700.

DECENTRALISED.



Same Area of 15 Miles Square with 20 Villages having a Total Population of 16.600 supplied by 4 Decentralised Pumping Stations at Villages B.G.L.&Q
Total Cost of Mains £ 42.625.

FIG. 3.

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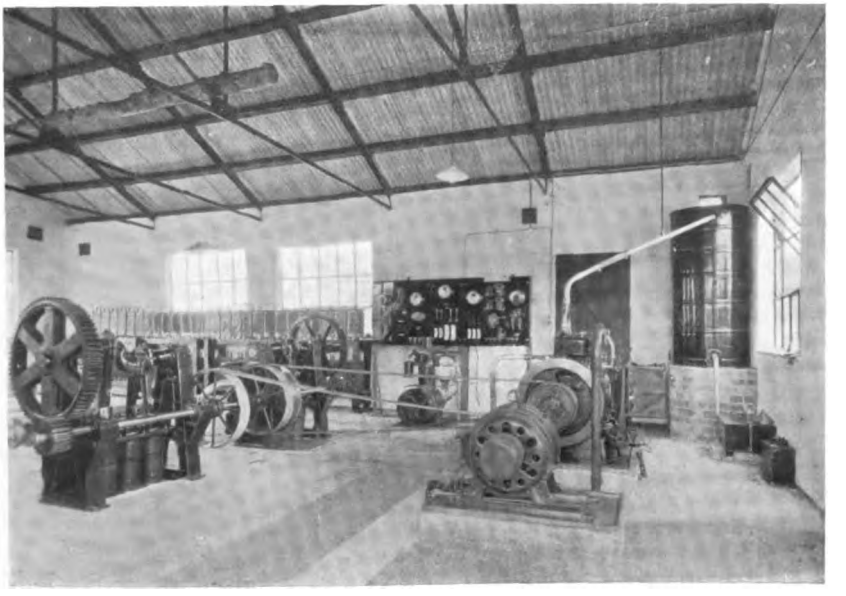
THE BRUSTON PATENT AUTO-PNEUMATIC SYSTEM OF WATER SUPPLY.



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Decentralization.

The effect of decentralization on the reduction in the sizes of the mains may be seen in the diagram (Fig. 3), taken from the paper read before the Public Works, Roads and Transport Congress (1927), by Mr. D. F. Worger, M.INST.C.E., M.I.MECH.E., to whom I am indebted for the majority of the information contained in this article.

Here, twenty villages are shown, supplied in the first instance from a centralized pumping-station, and in the second from four small "Bruston" stations. The saving in the mains is calculated in the latter case to be £18,075. In attendance costs there is also an appreciable saving, in spite of the fact that there are now four pumping-stations as opposed to one previously installed. In the former case, however, three attendants were necessary, working on eight-hour shifts, and being paid at approximately £150 per annum each. In the case of the Bruston automatic system, it would normally be possible for one man to superintend all four stations, but even allowing two attendants with motor bicycles to supervise two stations each, the saving obtained amounts to £150 per annum.

As the villages extend, it would be feasible to connect the four isolated systems up, firstly into two pairs and later into one system, thereby enabling the stand-by plant to be very materially reduced, as each station would then act automatically as a stand-by for any of the remainder.

In conclusion, I should like to acknowledge the further assistance given to me in the preparation of this article by Messrs. G. C. Pillinger & Co., in kindly permitting the reprinting of the information contained in their pamphlet, and by the loan of their plates for three of the illustration figures.

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DEVICES FOR CURING DAMP WALLS.

By COLONEL D. M. F. HOYSTED, D.S.O.

THE existence of damp patches in the walls of dwelling houses is normally the result of one or other of four principal causes.

These patches may owe their origin, firstly to the permeability of an outer wall to the percolation of moisture from rain driven against it, or secondly to the continued condensation of dew on the interior face, and thirdly to a leaky roof. But the fourth and most frequent cause of all is the rise of water from the foundation soil due to the absence of a protective device over the area of ground below the floor, or of a damp-proof course in the base of the walls themselves, or of both, and shows itself near ground level.

The first trouble should yield to a suitable treatment of the exterior with a coating of cement, rough cast, bitumen paint or petrifying liquid. The last-named, however, must be renewed every couple of years to afford continued protection.

The second is caused by the absence of a non-conducting coat on the inside of the walls and the consequent effect of a cold non-absorbent facing. This lack of covering offers a chilled surface for the convenient deposition of moisture from the warmer damp-laden inner air. The settlement of dew, by this operation, on walls of rooms and passages, is much more common in the North and West of England than it is elsewhere, and causes great inconvenience in many Depot Messes. It can generally be cured by a covering of non-conducting plaster on the interior surfaces involved. Common lime and hair plaster forms the best non-conductor; sirapite or any cement tends to destroy this quality.

In the third case, when dampness is evident in rooms above the ground floor, the trouble may be due to a leak in the roof covering: this can often be found by an investigation of the upper side of the roof from outside, and will generally be traced to a broken piece of the covering or a crack in a flashing. If the upper side gives no evidence, the under side should be examined where possible, during, or just after a rainstorm: the drip will probably be detected and can then be traced to its source. If the dampness has appeared above a fireplace or in a wall containing a chimney flue, it is probably caused by the passage of rain through a defective joint at the base of the chimney pot, or in the stack above roof level, or by the absence of a damp-proof course at the base of the chimney stack. For water finds

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its way down through the material of a wall as quickly as it finds its way up from below. This nuisance can be remedied by the renewal of the flaunching or by a protecting coat of cement, bitumen paint or petrifying liquid, as the case may be, applied to the chimney. The last-named does not interfere with the æsthetic appearance of the material to any appreciable extent.

The fourth case, however, is the most complex, and should be very carefully investigated before any action is taken, as there are several paths by which the water may reach the point at which it manifests its presence.

When the dampness appears in the lower portion of ground-floor walls, the object of primary investigation should be to ascertain whether the building was provided with an adequate horizontal damp-proof course at the base of every wall, just above ground level. The want of such a protection forms the most fruitful origin of all.

If such there be, the search must be conducted to the conditions below the floor itself. For under the floor there should be a concrete seal or adequate air space, and in it there may be a fault. For instance, on a wet site the damp may come through a carelessly or faultily laid under-floor seal and be able to work its way round the damp-proof course, *via* the accumulation of rubbish, and thereby reach the wall above, whence capillary attraction would be sufficient to take it to a height of three feet or so above the floor-level. If no such protection is present, it will have to be provided, either by excavating an efficiently ventilated air space below the level of existing damp-proof course and not less than 12 in. clear, between the ground surface and the under side of the floor joist, or by the provision of a 4 in. concrete spread below floor and damp-proof course.

The damp-proof course is sometimes loosely misnamed a damp course, but, obviously, its whole action depends upon its imperviousness.

Should there be no horizontal damp-proof course in the building, however, some means will have to be taken to provide protection from the effect of the rise of moisture upwards from the damp soil of the foundation through the material of the walls. It is useful to remember that the rise of such moisture by capillary attraction through the interstices of the wall material hardly ever manifests itself beyond 3 ft. or 4 ft. above the ground-level or points of entry, as long as the wall is not specially waterproofed on both faces.

It may also be borne in mind that, if a wall is well built in sound cement mortar, every joint will act more or less as a damp-proof course, and therefore the maladies under consideration should not affect it. They are generally confined to walls built in lime. The insertion of a horizontal damp-proof course in an existing wall thicker than 4½ in. is impracticable, except at a prohibitive cost, but in the case of thin partition walls of a horizontally bonded

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nature, such as brick, it can be carried out by cutting or even sawing a horizontal joint in lengths of about 3 ft. through the wall. This hollow is then well wetted and filled in with a waterproofed cement mortar, slate, bitumen, or other suitable material. When it has set thoroughly hard, the intervening portions are similarly dealt with, eventually forming in this way a continuous horizontal damp-proof course which will confine the moisture to the area below it. Such treatment might be undertaken in the case of a building in which the damp has appeared only near the bottom of a thin partition wall, but has not caused trouble elsewhere. Then, if the provision of such a damp-proof course above the damp patch is followed by rendering both faces of the partition below it with a suitable waterproof coat, the visible effect of the damp will be overcome. As long as this surface seal remains intact no harm occurs, and it will probably be unnecessary to continue the horizontal damp-proof course vertically down to the foundations. In most ordinary cases it will be unnecessary to go to the labour of making this horizontal damp-proof course through the thickness of the wall, as the trouble can generally be stopped by just using a vertical waterproof covering over the face of the wall itself as described below.

But if an efficient damp-proof course exists in all but a thin wall, which happens to be affected by the damp, it may be possible to insert one in that wall, at the same level as the existing damp-proof course elsewhere, by the method mentioned. It would then be necessary to join up the new damp-proof course with the other so as to maintain continuity. When that is done, the damp patch will dry out after the rise of water has been cut off.

In the case of thicker walls, the best remedy is to apply a waterproof cover either to the inner face or both faces of the wall to such a height that the force of capillary attraction cannot compete.

In the case of an external wall, when the site of the building is such that it is likely that moisture may dry outwards by natural evaporation into the atmosphere from the external surface, treatment of the inner face alone will suffice.

This waterproofing of interiors can be carried out by covering them with ½-in. waterproofed cement mortar, or a bitumen paint of some reputed make, to a height of 2 ft. or 3 ft. above the damp patch. Two coats of the paint are advisable, allowing the first to dry thoroughly before applying the second. The internal decoration can then proceed normally without further fear.

This bitumen paint is black, for which reason it might not be so applicable to external use owing to its appearance, as it would be to an internal face, which will probably be covered with paper or plaster.

But if efficient evaporation from the outside of the wall is unlikely, owing to surrounding trees or other preventive causes, then both external and internal surfaces must be protected In this event it

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should be remembered that the force of capillary attraction will be enhanced when both sides are sealed, and this fact may increase the height to which the moisture may rise, to some 6 ft. above the points of entry. Consequently it would be safer to carry the interior rendering up to the ceiling when both faces of a wall are dealt with.

There are one or two efficient makes of waterproof bitumen paint on the market, and at least one of these (Protex, by Callender & Co.) will adhere firmly to almost any surface, while having the further advantage of holding plaster without any additional key than its own adhesive property, provided the first coat of plaster is applied very thinly while the second application of the paint is still in a tacky condition.

There is also a Dutch method which is said to be effective for external walls, but which the writer has not actually examined. It has the great advantage, however, that it can be applied entirely from outside without disturbing the interior of the building, and should not be expensive. It consists of inserting 1½ in. diameter agricultural pipes in a line, about 3 ft. 6 in. apart and just above ground level, so as to extend some 7 ft. clear horizontally on either side of the damp area. A second course of pipes should then be inserted about 12 in. above the first and staggered. Each hole to be a good fit for the pipe, which must be in close contact with the wall material, but inserted without cement or fastening other than friction. Each pipe should extend from the outside of the wall to within 3 in. of the interior face of the wall, and should have a fall of ½ in. downwards and outwards. The lip of the pipe to project about ¼ in. beyond the exterior face of the wall. These pipes set up a circulation of air and draw out the moisture, thus enabling evaporation to complete the process and get rid of the water before it can rise above the upper row. They would thus fulfil the functions of an ordinary damp-proof course, and would be possible to apply to walls of any thickness.

Waterproof Cement.

When it is not possible to cover the construction with some suitable protection such as bitumen sheeting, bitumen or other paint, tar, etc., cement concrete may be more or less waterproofed either by making the mass itself more impervious to the passage of water, or by the application of some proofing substance after the concrete has set. At present these results are not absolutely satisfactory in all cases, though they will often fulfil limited requirements. The former method consists of filling up the interstices of the mass and lessening the voids in the concrete while it is being made, either by mechanical means or by the addition of small quantities of some insoluble substance in finely divided particles. It may similarly be applied to the rendering of the surface coat.

The mechanical means include grading of the aggregate, vibration, or the use of finer sand. Vibration should be effected when the

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mass is in position, such as in the case of piles, slabs, etc. If fine sand, is used it should be between thirty and forty mesh.

A waterproof effect can also be produced by rendering the surface of the concrete, while yet green, with fine stuff consisting of one part P.C. to two or even one of sand, and using a steel trowel to float the surface. This produces a smooth, glossy finish, thus indicating that there are practically no surface pores for the passage of water. But the disadvantage of this method, if used for the face of interior walls, is that it forms a surface which will facilitate the deposition of dew, so must not be used where such may be reasonably expected. Neat cement should not be used, as it tends to contract on drying and make haircracks.

In the second category may be reckoned the admixture of certain specific materials such as sodium silicate, or use may be made of the affinity of alum and soap to form an insoluble precipitate of hydrate of alumina. This can be brought about by mixing 21 lbs. of soft soap and 12 lbs. of alum in 30 gallons of water, and using the liquor for gauging the concrete. Another recipe gives powdered alum equal to 1% of the combined weights of sand and cement in the first half of the water used for the mix, and after that has been used, a similar weight of yellow soap in the second half. When soap is used, frothing must be prevented. Powdered sand, hydrated lime, powdered slate waste, up to 50% of the cement content, are sometimes used, but allowances must be made, as they tend to weaken the concrete.

There are many patent materials on the market which rely for their waterproof effect on the same agency : of these Pudlo is one of the chief. It is a fine white powder resembling finely-ground glass, which should be mixed with the neat cement, then added dry to the sand or aggregate and finally treated and wetted in the usual way. About 5% by weight of the pure cement is the measure of the Pudlo claimed to produce absolute impermeability. Ferrocrete is a prepared cement making the same claim.

In the case of an existing concrete mass, clean the hardened surface and then wash over with a solution of 2 oz. alum dissolved in a gallon of water at 60° to 70° Fahr ; brush it well in with a hard brush and allow to dry for 24 hours. Then apply a second wash of $\frac{3}{4}$ lb. castile soap to the gallon of water, and allow to dry for a similar period. This should be done four times. In the case of an existing tank, fill it with lime and water and keep it well stirred, so that the lime may fill the pores and close them. These treatments may have the necessary effect and save further expenditure.

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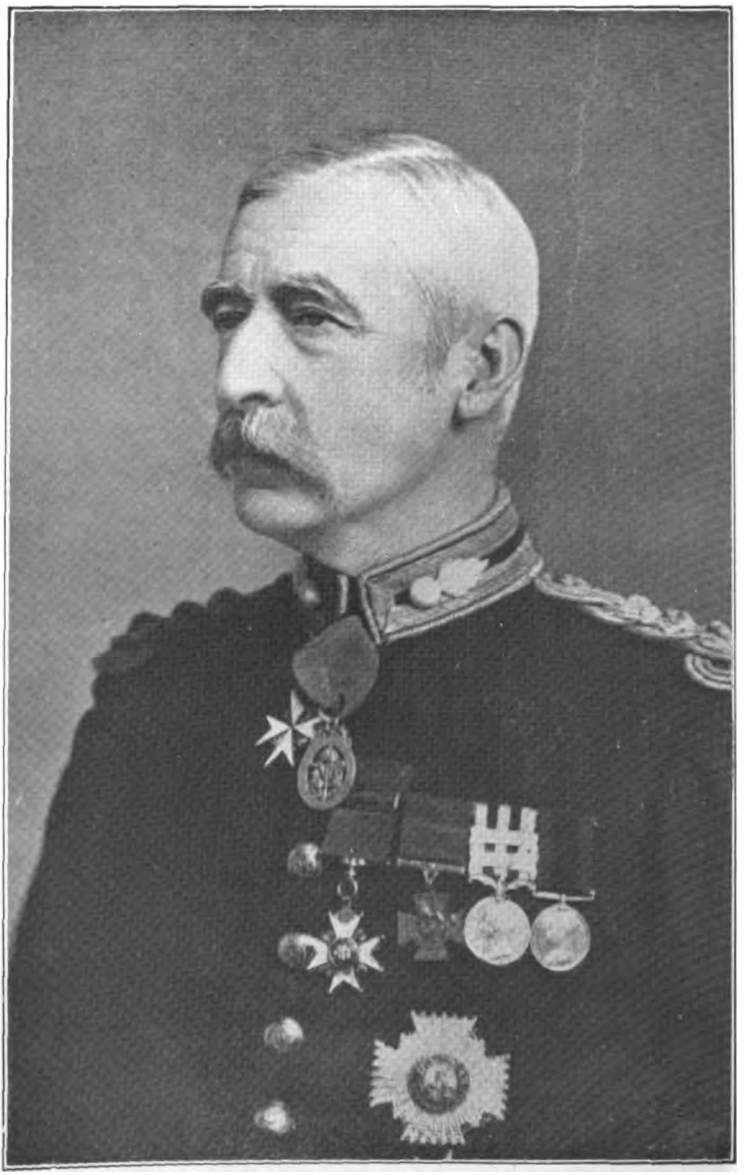

Colonel Sir Edward Talbot Thackeray, V.C., K.C.B.,
Royal (late Bengal) Engineers.

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MEMOIR.

COLONEL SIR EDWARD TALBOT THACKERAY, V.C., K.C.B., ROYAL (LATE BENGAL) ENGINEERS.* 1836–1927.

Foreword.

I AM honoured by being invited to write a few lines as an introduction to the accompanying very complete and interesting biographical notice of my old friend and brother-officer, Edward Thackeray, which is to appear in the next issue of the *R.E. Journal*; and I find that doing this is not a merely melancholy task.

Of course, there is the inevitable sadness at the departure of an old and much-esteemed friend and comrade; but there is also the glorious memory of a valiant and fearless soldier and true gentleman, who did his duty right well and greatly distinguished himself during his service in the Army, continuing to work afterwards, for the good of his fellow-men, until the end of his long life of nearly ninety-one years.

That this exceptionally long life of Edward Thackeray was a happy one, and that he was very highly thought of and esteemed by his brother-officers, by his many friends and by all who had to do with him, is well brought out in the following pages. Among the successors and descendants of the Indian soldiers who served under him his name is still affectionately remembered, and will long be so remembered.

I was one of his oldest friends. We first met at Chatham in the 'sixties, and during the next dozen years or so, I came across him now and then in India. In 1881–82, I served as his 2nd-in-Command with the Bengal Sappers and Miners, now "King George's Own," for six or eight pleasant months. Afterwards our ways lay apart, as he retired from the Army and settled in Italy, while I served on in India for many happy years. I last saw him when he visited England in the summer of 1926, and I had my last letter from him a few weeks before his death last year. As this letter referred to King George's Own Sappers, I sent it to Roorkee, where it is preserved with the Corps Memorials.

B. BLOOD.

59, Cadogan Square, S.W.1.
6th May, 1928.

ON September 3rd, 1927, there passed peacefully away, in his ninety-first year, one of England's oldest veterans. Sir Edward Thackeray

* An account of Sir Edward Thackeray's military services will be found in the Biographical Notice of Colonel E. T. Thackeray, V.C., C.B., in *Addiscombe, Its Heroes and Men of Mark*, by the late Colonel H. M. Vibart (Constable & Co., 1914), to which the present writer is indebted for some minor details.

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was the senior V.C., by more than twenty years, and almost the last link with the Honourable East India Company's Service—and its military college of Addiscombe, and with the Indian Mutiny. He was born when William IV. was King. It was nearly seventy-three years since he received his first commission, seventy since he won the Victoria Cross at Delhi, and thirty-nine since he retired from the Army. He was the *doyen* of the Knights of Grace of the Order of St. John of Jerusalem (1890) and a C.B. since 1886. But his active services, military and civil, did not cease in 1898, when his tenure of the Chief Commissionership of the St. John Ambulance Brigade came to an end. For the last twenty-eight years of his life, he had resided on the Italian Riviera ; and during the War, when Bordighera became a great military hospital base, he was President of the local branch of the Red Cross and Order of St. John—by no means an honorary office. For his services in the War he received the two medals, and a mention in dispatches. He was then over eighty, and he shared this unique record with his old friend, Lord Roberts—his campaigns bridging a span of more than sixty years.

The writer of this memoir has been urged by Thackeray's friends in the Corps to attempt something more than a mere recapitulation of his services in the field and in civil life. His great age—for he outlived nearly all his contemporaries—and the link he made with the past are in themselves reasons for a somewhat different treatment of the story of his life in the pages of *The R.E. Journal.* With this in view, the writer has ventured to include in the account of his career a more intimate description of his life and personal experiences. A record of nearly ninety-one years so devoted to duty, so mentally and physically active throughout, is one which sets an inspiring example. In the last three decades of his life, at Bordighera, he occupied a special place, and became the recognized leader of the considerable British " colony." His commanding presence and quiet dignity impressed all with whom he came into contact. The marked distinction of his personality expressed itself not only in temperament and action, but in outward appearance, for the one was the mirror of the others ; he was, as the Bishop of Guildford said of him in his memorial address, not only a very gallant soldier and able administrator, but a great English gentleman.

* * *

Four hundred years ago the name of Thackeray, in various guises, was common, as it is to-day, in the West Riding of Yorkshire. For generations, one branch were yeoman-farmers, of Hampsthwaite. In the late seventeenth and early eighteenth centuries, some of their sons went into the Church. It was from this stock, mingled with an ancient line of soldiers and squires, the Richmond Webbs, that Edward Thackeray came.

The great-grandson of an Etonian Head Master of Harrow (1693-

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1760): grandson of William Makepeace Thackeray, a pioneer of John Company in India under Clive and Warren Hastings: nephew of five uncles who all distinguished themselves and died in India, two being killed in action: younger son of the Rev. Francis Thackeray, historian and antiquarian, and of Mary Ann, *née* Shakespear, both of whom died in his boyhood: and a first cousin of W. M. Thackeray, the author—Edward Talbot Thackeray was born on October 19th, 1836. On the death of their parents, their illustrious kinsman looked after the interest of his young cousins, and they came to look upon him almost as a second father. Edward was at school at Marlborough from the age of eight to fourteen, where he learnt nothing, but had a very rough time, which, he used to say, afterwards stood him in good stead. As a boy, he earned a name for pluck and perseverance in many escapades. He was next sent to a private school at Walthamstow, from which place, pocketing the coach fare, he walked to London and back, to see the funeral of the Duke of Wellington.

He entered Addiscombe in 1853, through his cousin's interest, and received his commission in the Bengal Engineers in December, 1854, having passed out third in his term. Mathematics were his strong point, and in after-life, one of his relaxations. He was something of a dandy, and was called 'Lord Talbot,' or 'The Duke,' by the cadets. After two years at Chatham, he sailed for India in the *Ripon*, which had to put into Corunna, after fighting gales in the Bay of Biscay for three days. The journey across the desert from Cairo to Suez was done in a mule-and-horse-drawn caravan, song and whist and bottled beer helping to pass the time. Arriving at Calcutta in January, 1857, he was posted to the Bengal Sappers and Miners at Roorkee. He was fortunate in having many family connections in India, among them Colonel Sir Richmond Shakespear, Colonel A. Irvine, General Sir John Low and Sir Theophilus Metcalfe, Commissioner of Delhi. Before proceeding up country, he stayed in Calcutta with another cousin, William Ritchie, Attorney-General, and afterwards Member of the Governor-General's Council.*

It is not proposed to enter here upon a detailed history of the Indian Mutiny, in which Thackeray was only a junior subaltern. It will be sufficient to notice the principal actions and incidents in which he took part.

On Sunday evening, the 10th May, the Mutiny broke out at Meerut, followed, as is well known, by the unaccountable inaction of the troops on the spot, under inept command. On the 15th, the Sappers and Miners, summoned from Roorkee, reached Meerut by canal, under Captain Frazer. Many dead bodies of villagers, murdered by dacoits in the rioting, floated past them.

* A son and a grand-daughter of Mr. Ritchie married Sir Edward's daughter and third son. The late Sir Richmond Ritchie, Permanent Secretary of State for India, another of Mr. Ritchie's sons, married Anne, daughter of W. M. Thackeray.

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Next day, Lieut. Thackeray was ordered to take an armed party of 90 sappers outside the city to dismantle some walls. After working some time, a trooper of the mutinied 3rd Cavalry galloped along the road to Delhi, shouting, whereupon the sappers threw down their tools, took up their arms, and, for the most part, followed the *sowar* towards Delhi. The young officer, having ordered the bugler to sound the Assembly, succeeded, with the assistance of the three European N.C.O.s, in getting 36 men to fall in. With these he marched back to Meerut, to find that the Corps had mutinied on parade, and shot their Commanding Officer. It was his first taste of war, and he had risen to the occasion. Weakness or hesitation would have meant wholesale desertion, and the massacre of himself and his British N.C.O.s. It is a mystery why the sepoys spared him. Perhaps it was a tribute to the " cool intrepidity " of the young *sahib*, which was soon to win for him the V.C. at Delhi. Thackeray's Addiscombe friend, David Ward, carried out a similar duty on the same day, but the men had no incitement to desert, and he marched them back to the lines. The remaining mutineers fled from the Cantonment, and a party of 50 were followed and cut up by the Carabineers. Ward volunteered to take charge of the party that went out to bury the dead, and brought them back after this hazardous duty. A few of the Sappers remained faithful throughout the Mutiny; others rejoined when it was over, did good service, were promoted, and served under Thackeray again, as Commandant, twenty-five years later.

The troops, under Brigadier Archdale Wilson, made their tardy advance upon Delhi from Meerut on 27th May. Thackeray took part in the actions on the Hindun, and the battle of Badle-Ka-Serai, which gave us the Ridge. He served throughout the siege of Delhi, from the 8th June till 20th September, 1857, being employed in laying out the batteries. This exposed duty cost many lives, among them that of his greatest friend, Edward Jones, first in his term at Addiscombe, who had voyaged to India with him.* Thackeray earned a reputation for conspicuous gallantry in the Homeric struggles which have given the Ridge its deathless name. His cousin Metcalfe's ruined house, burnt and sacked by the rebels, and swept by shell, was one of the principal strong points. At the assault of Delhi, on 14th September, he was in the Reserve Column, which followed through the Kashmir Gate, a few minutes after it was blown in. Ten out of seventeen Engineer officers engaged in the assault were either killed or wounded. Our hold on the city was precarious, and for several days there was hand-to-hand fighting from house to house. It was the duty of the Engineers to break through the walls, and loophole and fortify the ground gained.

* Jones's vivid letters home have been kindly placed at the writer's disposal by his relatives.

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On the 17th, we had gained possession of the Magazine, famous for Willoughby's defence on the 11th May, when he blew up the powder store, rather than leave it in the hands of the rebels. It was again a point of vital importance, the loss of which might have imperilled our hold on Delhi. Once more, it has been said of this occasion, the fate of India depended on the action of a few brave men. Sir James Outram in his dispatch wrote, " Magazine carried this morning with loss of only 3 wounded. A dash and cheer struck such terror that the rebels dropped their lighted portfires, leaving their loaded guns an easy prey to us. 125 pieces of cannon and vast supplies of shot and shell found in the magazine alone." The enemy made determined attacks, and finally set fire to some thatched sheds inside the magazine, beneath which live shells were stored. Lieut. Renny, of the Artillery, mounting the wall, threw shells with lighted fuses among the enemy, and many other deeds of heroism were done on this occasion. Among those who most distinguished themselves was Lieut. Thackeray. He climbed on to the blazing roof, and a gallant Indian servant handed *mussacks* (leather water bags) up to him. He did not descend until he had successfully extinguished the flames, the rebels firing and throwing missiles at him at close range.

Lieut. Renny was given the V.C., and others who shared in this exploit appear to have received distinctions. Thackeray was thanked by the General in command, and mentioned in Sir Archdale Wilson's dispatch of 20th September, 1857. But it was four-and-a-half years before he was awarded the V.C. (in the *London Gazette* of 29th April, 1862) for " cool intrepidity and characteristic daring "—four words which well sum up Edward Thackeray's imperturbable *sang-froid*—" in extinguishing a fire in the Delhi Magazine enclosure on 16th September, 1857, under a close and heavy musketry fire from the enemy, at the imminent risk of his life from the explosion of combustible stores in the shed in which the fire occurred." By Her Majesty's command, conveyed in a letter deeply regretting her inability to bestow the decoration in person, the presentation was made by the G.O.C. on a general parade at Dover, in August, 1862.

The circumstances under which the recommendation for the coveted decoration was not submitted for two, and its presentation delayed for five years, enhance the interest of the exploit. Thackeray's special part in it had not officially come to light. This, as is pointed out in the letter from Colonel Baird Smith, Chief Engineer at Delhi, and Major (afterwards General Sir F. Maunsell), his C.O., was due to the modesty of the young officer, the only Engineer officer present, though he had been instrumental in obtaining the V.C. for Renny. The letters throw an added lustre not only on this signal deed of valour, but on his complete contempt of danger at all times.

After the siege, he served with the column under General Showers

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in the Mewattee district, and was present at the capture of Fort Jhujjur. He next accompanied the column under Sir T. Seaton, which marched from Delhi to Lucknow in December, 1857, and was present at the actions of Gungeree, Puttialee and Mynpooree. After serving with the Engineer Brigade, under Col. Robert Napier, in the operations ending in the capture of Lucknow under Lord Clyde, he accompanied the Rohilkund Field Force in April, 1858, and was present at the capture of Fort Rooyah, when his horse was shot under him. On this occasion, not wishing to lose the saddle and bridle, he coolly removed them, under fire from the fort, and followed the attacking party on foot, carrying them on his head. On another occasion he took part, as a volunteer, with the Carabineers in a cavalry pursuit, and the capture of a baggage train and elephants. He envied the daring exploits of his life-long friends, the Horse-gunner V.C.s, Olpherts, Tombs, Hills-Johnes, and Roberts. He was at the action of Allygunge, and the capture of Bareilly, on 5th May, 1858, and served also with the column under Sir George Barker, in the operations at the end of 1858.

The experiences of the Mutiny had a marked effect on Edward Thackeray's sensitive temperament. It was said by his cousins, the Ritchies, that the high-spirited boy of twenty had in these two years become a grave and serious young man. He had suffered in mind and health, and the scenes through which he had passed at that early age left, it was felt by those who knew him at that time, an indelible mark on his character.

After the siege, he was appointed Personal Assistant to Col. Crommelin, C.B., Chief Engineer of Oudh, and acted in the same capacity to Sir Robert Napier at Lahore. Three years afterwards, he became Executive Engineer of Upper Assam, and was employed on surveying and making a reconnaissance of the unexplored country occupied by the hostile Abors, bordering on the Dehong and Debong rivers. It was fifty years later that we sent an expedition to occupy the country. The district was invested by wild buffaloes, and he secured some fine shooting from elephants.

He was an enthusiastic all-round sportsman. Shooting was his favourite sport, but he was also a keen fisherman. Oddly enough, he only shot one tiger. Sitting up in a *machan*, or long waits behind cover, bored him ; he preferred stalking his game on foot. He was once nearly killed by a charging tiger, which was brought down at his feet by a friend. He played polo, racquets and tennis in the days of their infancy in India, but cared less for games than sport. He was very fond of the sea, liked handling a sailing boat, and was a good swimmer. At nearly eighty, his doctor at Bordighera had positively to forbid him bathing any more. In his day, he was a bold rider after pig, and took part in the earliest meetings of the Meerut Tent Club, when the Kadir Cup was started. He hunted regularly

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when on furlough in England. In the 'sixties, amongst his friends in the hunting field were Anthony Trollope and John Leech, the *Punch* artist, whom he often met at W. M. Thackeray's.

His first wife, whom he married in 1862, died in 1865. In 1869, he married a second time. Particulars of his family are mentioned later. Seeing no immediate prospects of active service, he entered the Public and Military Works Department, and, from 1867 until 1879, held various posts as Garrison and Executive Engineer, building barracks and hospitals at Gwalior, Allahabad, Meerut, Umballa, etc. In 1871, he officiated as Secretary to the Government, for designing improvements in Fort William, Calcutta.

On the outbreak of the second phase of the Afghan War in September, 1879, Major Thackeray, though he had been departmentally employed for many years, was selected, as an officer of known worth, for the command of the Bengal Sappers. He had always kept abreast of the times, practically as well as theoretically, doing duty and attending manœuvres and courses at Dover and Chatham when on furlough at home.

Thackeray joined his command in October. It consisted of the 2nd, 3rd, 5th and 6th Companies, echeloned along the Khyber Pass. The remaining companies were with other columns. Riding up the Pass to his H.Q., he had picked up a big Afghan hound ; and he used to describe a hunt which he had for miles after a wolf. It was on the borders of the hostile hill country, where keen-eyed Afghans sat behind rocks with their *jezails*. The wolf appeared to lollop along quietly, but drew away when he increased speed, and he lost both hound and wolf.

The circumstances of this phase of the Afghan War may be of interest, and are briefly as follows. During 1878–1879, Afghanistan had been occupied by the British after a victorious campaign. A peace had been patched up. Our army was withdrawn and the Amir, our nominee, agreed to accept an Envoy and his suite at Kabul. Sir Louis Cavagnari was appointed, and reached Kabul in July. On 3rd September, he and his escort were massacred. The withdrawal of troops was at once stopped, and measures for reinforcement taken.

Sir Frederick Roberts occupied Kabul, and the tribes seemed to quiet down. But, early in December, the whole country blazed up into revolt. Roberts, with some 6,000 men, was invested in Sherpur, a cantonment outside Kabul. His communications with India by the Khyber Pass were seriously threatened. The supply and reinforcement of the army at Sherpur, and the security of the Khyber defiles, were of vital importance.

Brigadier-General (afterwards Sir) Charles Gough, V.C., commanded the leading, but very weak, brigade of General Bright's Division. There has been some controversy over his gallant advance on Kabul.

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The facts are that he received contradictory orders from General Roberts, commanding the Kabul Field Force, and General Bright. On 13th December, General Bright directed him to advance and occupy the Pezwan, Jugdulluck Fort, and Jugdulluck Kotal posts, which he did on 14th December. The same night, he received orders direct from General Roberts to march to Kabul at once, warning him at the same time that the Ghilzais would probably rise, and that the enemy in front of Sherpur numbered 30,000.

The strength of Gough's brigade was only 12 guns, 230 cavalry and 1,545 infantry. A few days earlier, the Guides, under Colonel Jenkyns and Major Fred Battye, had marched to join Roberts. Dropping tents and baggage, they made an almost continuous march of nearly 40 miles, over two bleak passes, in bitter cold—a marvellous performance comparable to that of Montrose in 1645. The three advanced posts, and the advanced base at Gundamak, now absorbed all except about 500 men and 4 guns. The telegraph was cut, and he had to depend uncertainly on the heliograph. He reported to Bright that in his opinion the operation was too risky. Bright concurred, whilst taking steps to reinforce him. On 20th December, Gough received another peremptory order from General Roberts, through Colonel Hudson, commanding the isolated Lattaband detachment, to advance without further delay, ending " There is nothing to stop him."

Gough could hardly share that opinion. For a week, his posts had been heavily attacked by increasing numbers, and an enormous gathering of Afghans was collecting in front of him. " The end of December was occupied in crushing the most formidable combination which ever opposed the British in Afghanistan; 60,000 enemies took the field." (Dr. T. M. Maguire.) Simultaneously with calls from Roberts to advance " at all hazards," Gough received strict orders from Bright not to move beyond Jugdulluck. However, the urgency was great, communications slow and uncertain. He decided to march on the 21st with 1,435 men and 4 guns. He also boldly determined not to abandon the three posts, now garrisoned by some 1,300 men and 4 guns.

The unexpected happened. Picking up the Lattaband detachment, Gough entered Sherpur on 24th December, without seeing a single hostile tribesman or hearing a shot fired. The Afghans, repulsed with heavy loss by Roberts, had raised the siege. The three posts left in Gough's rear seem to have acted as a bait, and drew the attention of the hordes of Ghilzais away from his small column. It needed bold and skilful leadership and brave troops to defend these isolated points against such odds.

The foregoing *résumé* has been by way of a digression. It is with the attacks on the small fortified posts that this chronicle is directly concerned. The operations during the last three months of 1879 are

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described in detail in a memorandum by Lieut.-Colonel Thackeray (R.E. Institute, 1881), as well as in the various histories of the war. During October and November, work proceeded quietly on the advanced posts, improving roads, etc., and with preparations for a standing camp at Gundamak. Telegraphic communications were established forwards and to the rear. The troops suffered greatly from sickness. The cold was intense, and gales and dust storms impeded the work. Underground shelters had to be constructed for troops and working parties. Convoy work went on, and few shots were fired. But it was not safe to move unescorted, and occasionally single men were murdered. It fell to the Sappers under Major Thackeray to burn a village implicated in one of these murders. Early in December, the Ghilzai workmen began to desert, and information pointed to an imminent rising on a large scale. Very heavy fighting took place round Kabul.

As already explained, General Gough, pursuant to orders, marched from Gundamak on 14th December. The whole country seemed to have risen in arms to bar his further progress, and daily skirmishes took place between the enemy and the troops escorting the convoys between Pezwan and Jugdulluck. On arrival at the latter post on 14th December, General Gough, after a minute inspection, gave instructions for its defence, and placed Major Thackeray, who, leaving his H.Q. at Gundamak, had accompanied his advanced detachments, in command of the post at Jugdulluck Kotal, about four miles from the fort of the same name. Work proceeded at once at the three posts, improving the defences by traverses, *sangars*, ditches and wire entanglements. Water was a very serious problem, and water tanks had to be improvised by lining pits with waterproof sheets. The telegraph having been cut, heliograph stations were established near the posts.

On the 15th, a party of four *sowars* of the 10th Lancers was fired upon, one was killed, and two men, one wounded, rode into the Kotal with the horses. Major Thackeray went out with a party of Lancers, and captured three Afghans, who were sent for trial. That night, Jugdulluck Fort was unsuccessfully attacked, the enemy, numbering about 5,000, collecting with their standards on all the surrounding hills.

On the 17th, Major Thackeray made a reconnaissance towards Pezwan. The enemy were met with in great numbers, and at the same time a reconnoitring column sent from the Fort by General Gough, under Major Macnaghten, 10th B.L., came on the scene. Major Thackeray placed his troops at the disposal of Major Macnaghten, his senior. The action that ensued is described in General Gough's dispatches, dated Kabul, Dec. 26th, 1879.

"On December 17th, I sent Major Macnaghten, commanding the 10th Bengal Lancers, with two companies of infantry and 40 cavalry, to reconnoitre the road towards Pezwan and ascertain the enemy's

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strength on that line. Major Thackeray, V.C., commanding at the Kotal, was requested to hold the heights, whilst troops were sent from the fort to crown the heights along the pass. Major Macnaghten found the enemy, over a thousand men, posted across the road about two miles south of the Kotal. He attacked them vigorously with his small force, supported by a company of Sappers placed at his disposal by Major Thackeray, and drove them back some distance, completely clearing the road, and inflicting some loss on them. Major Macnaghten did his work well . . . He also mentioned the assistance he received from Major Thackeray, V.C., commanding the Sappers."

Before returning to the Kotal, Major Thackeray, having obtained permission, took the opportunity of destroying the village previously mentioned, as a punishment for its share in the murder of a Sapper sepoy. It was getting dusk, and the enemy were in force on the neighbouring hill tops. Leaving half the company on the crest in reserve under Lieut. Gordon, Major Thackeray sent Lieut. J. C. Campbell racing down to the village, burnt such stores and fodder as could not be carried away, and returned to the Kotal. That night, another attack was made on the Kotal, and repulsed.

A very characteristic incident took place at this time. One afternoon, wishing to see the General, Thackeray walked over alone from the Kotal to the Fort. General Gough was amazed to find he had come without an escort, and told him he had no business to be alive. He gave him a horse and an escort of *sowars* to take him home, much to the Major's disgust.

Not a day passed without skirmishing. The Ghilzais and Hazaras would not meet our troops in the open, but harassed the long convoys of baggage animals and followers. Besides having large escorts, they had to be covered by protecting columns of all arms. On the 19th, Major Thackeray found it necessary to drive the enemy from a number of newly constructed *sangars*, which commanded the convoy route. This hazardous duty was well carried out by the Sappers and Gurkhas. In the afternoon, " the enemy were observed to be advancing in considerable force with standards and banners from the hills. Their advance was made in regular order, some were dressed in white and some in khaki, and all appeared to be armed with guns, rifles or *jezails*, and Afghan knives and *tulwars*." With the help of the mountain guns, their advance was checked, and the convoy having passed, the troops returned to the Kotal. At night, the enemy made another attack. " The Ghilzais raised much shouting, and called upon the Mussulmans to come out and join them. Receiving no replies, except an occasional volley," they withdrew.

On the 21st, General Gough marched from Jugdulluck Fort to Kabul, as already described, leaving the three posts to hold their own. Of these, Jugdulluck Kotal, an old stronghold, commanded by surrounding heights, was the weakest and most vulnerable. Two guns of the Hazara Mountain Battery, and a section of Bengal

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Lancers, had been detailed for its garrison, but could not be spared. The garrison now consisted of 294 men (2nd and 3rd companies of Sappers, commanded by Lieuts. J. C. Campbell and Dove respectively, and one company P.N.I.), with Lieuts. C. Randolph and Gordon, all R.E., and Lieut. Blunt, R.E. Signalling Officer, with a British signalling detachment.

On the afternoon of 23rd December, a most determined attack was made on the Kotal, the enemy showing much more boldness. They approached to within 30 yards of the Kotal, gathering under the S.E. wall, which was difficult to defend, and throwing up *sangars* on the principal spurs. They numbered about three thousand, under Sirdar Amanullah Khan and the principal chiefs. One assault succeeded another from two o'clock onwards. The enemy kept up incessant cries of "Allah," calling on the Mussulman sepoys to desert. The night being clear, fire was maintained by the light of the moon on all sides of the fort, the Afghans attacking in force, with much drumming and shouting. But the small garrison gallantly held their own. It was nearly midnight before the attack died down. Thanks to the skilful manner in which the post had been fortified out of scant material, and strengthened during the attack, our casualties were only five—the Commanding Officer and one man wounded, three men killed or died of wounds. The enemy lost heavily.

At about 4 p.m., Major Thackeray had been wounded, whilst directing the fire from the east face. Colonel J. C. Campbell (then Lieut.) describes Thackeray's complete nonchalance and indifference to danger, on this, as on all occasions. He was standing exposed, the better to see, giving his orders to his Adjutant, Lieut. Gordon. It was pointed out to him that an Afghan at close range was taking deliberate aim at him. He went on without paying the least attention. The Enfield bullet lodged in his right forearm, shattering the bone. During the remainder of the attack, he continued to direct operations, in spite of the severity of his wound, from the mess and hospital tent, which was protected by a rough construction of round boulders and brushwood, the best that could be done with the materials available. When things were at their hottest, he gave permission to use some old hand grenades; but it was decided they were more dangerous to the thrower than to the enemy. The danger of the desertion of Mahomedan sepoys to the enemy, encouraged by the shouts of the Afghans, added greatly to the commanding officer's anxieties, with his experiences in the Mutiny ever present in his mind.

This was the last attack on Jugdulluck. Next morning, the two neighbouring posts hurried to the support of the Kotal. The enemy had suffered severely during the ten days fighting, considering the cautious tactics from behind cover: and they dispersed, as reinforcements were pushed up. Major Thackeray was sent back to India,

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the wound being a very severe one, aggravated by a piece of his *poshteen* coat being carried in with the bullet. He narrowly escaped the amputation of his arm. The same year, he was invalided to England, and saw no more of the fighting. In this he, no less than the Corps which he commanded, was unfortunate, for he had already attracted the attention of those under whom he served. Officers who were with him paid tribute to the tactical skill with which he handled his men and to his qualities as a leader, when assailed by greatly superior numbers. " He had," said one of them, a cavalryman, " the true method of dealing with Afghan tribesmen by bold attack and manœuvre, using his fortified post as a *point d'appui*. From this he sallied forth, frustrated the coalition, and marched back to defend his post against the remainder, when they came on the scene."

For his services he received mentions in the dispatches of Sir F. Roberts and General Gough, and the Afghan medal. In the opinion of the historian, Colonel Hanna, the force under General Gough did not receive all the credit, or obtain the rewards, that their hard fighting and marching deserved. In 1886, Colonel Thackeray was created a C.B., when Lord Napier of Magdala wrote to him that no man ever earned a decoration more completely on his own merits.

He returned to India in 1881, resuming the command of the Bengal Sappers and Miners at Roorkee. During this time, he served under the Duke of Connaught, who showed a friendly regard for the old Mutiny veteran all his life. At Roorkee, the name of " Tickery Sahib " was affectionately remembered for many years after he left. In 1884, he became Colonel. Having completed seven years as Commandant, Colonel Thackeray was, after a period of sick leave, employed in 1887–88 in the Intelligence Branch of the Q.M.G. in India, and in the compilation of *précis* of information relating to Sikkim, Bokhara, Baghdad and Borneo, a work for which he received the thanks of the Commander-in-Chief in India. He retired in 1888, his health rendering further service in India inadvisable.

From this point, Thackeray's active military service ceased, though he was, thirty years later, to take part in a different capacity, in another and greater war.

On his last voyage home, his only free passage in one of the old Royal Naval Transports, the following apt " Limerick " appeared in the paper published on board ship, among the rhymes describing the various officers and their idiosyncrasies. It may serve as an epilogue to his Army career :

" There's a grey-haired old Colonel on board,
Whose breast tells a tale of the sword.
Though otherwise shy,
He can chase ' x ' and ' y,'
But by boasting he never has bored."

* * *

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In 1862, Lieut. Thackeray, as he then was, was married, from the house of Mr. W. M. Thackeray, to Amy, daughter of Mr. Eyre Crowe, a well-known journalist and editor, of Paris, and grandfather of the late Sir Eyre Crowe, of the Foreign Office. His best man was Richard Harrison, now General Sir R. Harrison, G.C.B., Colonel Commandant, R.E., and one of the very few survivors of the Mutiny. He recalls meeting his friend in the Park, the day before the wedding, when he was invited to officiate the following day, the bridegroom-to-be having forgotten the necessity for this formality. Mrs. Thackeray accompanied her husband to Assam, and died at Allahabad in 1865. She left two daughters, the elder of whom is Mrs. Ritchie, widow of Gerald Ritchie, of the Bengal Civil Service. In 1869, Captain Thackeray married secondly Elizabeth, eldest daughter of Major T. B. Pleydell, of Blagdon, Devon, who survives him. A much-loved daughter died at Roorkee in 1882. The eldest of his four sons is Colonel E. F. Thackeray, C.M.G., D.S.O., a well-known figure in South Africa, who commanded the South Africans at Delville Wood. Sir Edward's elder brother was the Rev. F. St. J. Thackeray, a master at Eton and vicar of Mapledurham.

After his retirement, for about ten years, Colonel Thackeray lived near Dulwich College, interesting himself in local affairs, and writing reminiscences of the Mutiny, travel and sport in India, and a Biographical History of the Bengal Engineers. But his principal work at this time was in connection with the Order of St. John of Jerusalem. He had been appointed a Knight of Grace of the Order, and in 1892 was chosen by H.R.H. the Grand Prior as the first Commissioner (afterwards Chief Commissioner) of the St. John Ambulance Brigade. Major-General J. C. Dalton, R.A., a Bailiff Grand Cross of the Order, and for many years Chief Commissioner of the Brigade Overseas, has very kindly written an account of the Brigade and of Sir Edward's work. From comparatively small beginnings, the Brigade is now of imperial and world-wide importance. "This splendid result," says General Dalton, "is largely the outcome of Sir Edward's exertions; his quiet, courteous demeanour made him universally popular, and his untiring energy, devotion and talent for organization led to the rapid extension and great popularity of the movement throughout the country . . . The Order is the poorer for the passing of a gallant soldier and high-principled Christian gentleman." The administrative duties and responsibilities of the Brigade kept the Chief Commissioner busily employed, and he travelled all over England with his friend, the first Lord Knutsford, Director of the Brigade, on visits of inspection. For his services to the Order he was, in 1897, promoted to be a Civil Knight Commander of the Order of the Bath.

The same year, he left London permanently, and, after staying in Malta, finally settled, at the end of 1898, at Bordighera, where he and

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Lady Thackeray lived for the remainder of his life. They took a leading part in the life of the place. Sir Edward identified himself with every serious movement, and in many ways exercised a very remarkable influence. He was loved and admired by all, and made many friends among the Italians, with whom his relations, personal, as well as official, were most cordial. His quiet courtesy and dislike of the petty squabbles of a small community in a foreign country, coupled with his strikingly distinguished bearing, impressed residents and visitors alike, and had a very real effect. He was President of several institutions, imperial and patriotic, as well as local; for every public-spirited or charitable movement, Italian or British, enlisted his active support, and he represented England locally on Italian platforms as late as his ninetieth year. In all his activities he was assisted by Lady Thackeray, on whom he leant more and more for support.

He was a man of many resources. Among these, chess and painting in water-colours were his chief recreations. Like one of Browning's characters, "Mathematics were his pastime." He was nearly eighty before he gave up bicycling; and expeditions up the lovely Riviera valleys, or to the Swiss and Italian lakes, with easel and paint box, gave him intense pleasure. Painting materials had invariably formed part of his kit on his shooting expeditions in India, sometimes together with a violin or a clarionet, which he played for his own amusement only, and, as he was ready to admit, with more pleasure to himself than to others. These active pursuits reconciled him in some measure to the lack of sport. After his retirement, living near London, his opportunities for it had been only occasional, whilst at Bordighera there were none. His last bag, however, was a brace of grouse which he brought down very neatly in his eighty-fourth year, on a Welsh moor.

Though naturally of a somewhat solitary bent, in London he enjoyed club life, and was at different times a member of several clubs. At the time of his death, he was the senior member of the Athenæum, his name having been put down for it when he was a young man by W. M. Thackeray. He was elected in 1874. He was also a F.R.G.S. and a member of the Authors' Club, for which he had a special regard. Though he hated making speeches, he was sometimes induced to speak at their dinners, and at The Savage Club. For many years, he had belonged to the East India United Services, amongst other Clubs and Institutions.

He spent much of his leisure time writing on military subjects. From 1914 to 1916, his *Sieges and the Defence of Fortified Places in the Nineteenth Century* appeared in *The R.E. Journal*, and afterwards in book form. It was a work involving an immense amount of research and labour for an octogenarian writer. For many years, until after the War, he regularly contributed translations of Italian

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military articles to *The R.E. Journal.* He often wrote memoirs of his old friends, under or with whom he had served, that of Sir Alexander Taylor, one of Delhi's greatest and least honoured heroes, being the most important. Another was of Hodson, of Hodson's Horse, for whom he had an unbounded admiration, and against whom he would listen to no detraction. He was an occasional contributor to *The Cornhill Magazine,* some of his articles being reprinted in his *Reminiscences of the Indian Mutiny and Afghanistan* (Smith and Elder, 1916). His other published works include *From Assam to Kashmir* (1893), being notes on sport and travel, privately printed, with illustrations from his own sketches ; *Two Indian Campaigns* (1896), *The Royal (Bengal) Engineers* (Constable, 1900) ; and *Environs of Kabul,* a book of photographs, with historical and other notes, published after the Afghan War. His writings are often unexpectedly interspersed with notes on science, natural history and archæology. His memory was amazing, not only for the minutest details of his life and verses which he had learned in his youth, but even in his last years, he could memorize pages of modern poetry, when it took his fancy, such as Ralph Hodgson's *Song of Honour.*

The principal event of these years at Bordighera was the establishment there, during the War, of the Head Quarters of a British Military District, and one of our principal hospital bases. Sir Edward, as President of the local branch of the Red Cross and the Order of St. John, held an important position, and exercised considerable influence. Each year, he and Lady Thackeray made the arduous journey through the war zone to London and back—a practice they kept up till the year before his death. As already stated, he was mentioned in dispatches by Lord Cavan, the British Commander-in-Chief, and received the two war medals.

Independence and self-reliance were the keynotes of a strong character. After careful consideration, he saw his way clear and straight before him, in the big as in the small things of life, and marched along the road he set himself, unmoved by and unconscious of conventional opinions. There was nothing in him of the military pedant or drill-sergeant. An officer who served under him in Afghanistan goes so far as to say of him that, as soldier and man, he was made of the stuff of Stonewall Jackson, and Bishop Greig numbered them both among the band of soldier-saints. The comparison is perhaps too bold a one, but it needed war to bring out the qualities of each as men of action. Henderson says of Jackson, the quiet mathematical professor, that " whilst campaigning was entirely to his taste, life in barracks was the reverse." The latter was not the case with Thackeray, but he was less in his element in orderly rooms and on parade grounds than in the field, or in scientific pursuits. Opportunity missed him. He certainly had much in him of the scholarly old Indian generals, such as Havelock and Outram, who

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fought none the worse for their learning and Shakespearian quotations. His qualities might have found a wider scope in the more adventurous and less sophisticated India of his forefathers.

In June, 1927, Sir Edward and Lady Thackeray went to Garessio, a summer resort in the Maritime Alps, instead of to London. They drove along the coast, and up the valleys, through the scenery he loved, and was to look upon for the last time. He kept his usual health during the summer, still went for drives and picnics, played chess, and even sketched, daily. He had at length consented to use a bath chair, though he still resolutely refused all other assistance, often to the alarm of his friends. But, at the end of August, a slight chill attacked the lungs, and, after an illness of only three days, he passed away, without suffering, on September 3rd, conscious almost to the end. His last words were of India. In a few days it would have been seventy years since he won his V.C. at Delhi.

His body was carried back to Bordighera—his last journey down the Italian valleys to the Mediterranean. His resting place is in the British cemetery, near the soldiers who died in the War, among the palms and cypresses. The *Podesta* (Mayor) and other civic functionaries, together with large numbers of Italians, came with his own countrymen to pay their last respects. Funeral parties were furnished by the *fascisti* and the *combatenti* (ex-soldiers), in whom he had always shown the liveliest interest. For he was greatly loved and revered by British and Italians alike at Bordighera, where his name will not soon be forgotten. A proposal is on foot, on Italian initiative, to name part of the sea-front after him.

A memorial service was held in London, at St. Mary Abbott's, Kensington, at which the Bishop of Guildford (formerly Bishop of Gibraltar) gave an address. His old friend, and second-in-command at Roorkee, General Sir Bindon Blood, as Representative Colonel Commandant, R.E., was present on behalf of the Corps, and of King George's Own Sappers and Miners; and Major General G. Walker, of the R.E. at Chatham. The Order of St. John of Jerusalem and the Authors' Club were also represented.

Such are the outlines of a long life, in which to the end an indomitable spirit and untiring devotion to duty were coupled with a great humility and a singularly charming courtesy. At Bordighera, not less, it is hoped, than in the Corps to which it was his greatest pride to belong, will his memory long remain green.

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BOOKS.

NAPIER'S "PENINSULAR WAR."

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The English, as Lord Balfour said some years ago, are a fighting but not a military race. Glory is not a word that appeals to them. They underwent once, indeed, a military schooling which left its mark even on the work of such men as John Milton and Andrew Marvell; but it endured not long, nor has the like of it ever recurred. Fighting, on the other hand, has been widespread and continuous to a degree that is suspected by only about one Englishman in ten thousand; and, singularly enough, there is hardly an expedition, however insignificant, since 1660, of which there does not remain some printed contemporary record, if only in a pamphlet of a few pages. If the adventure issued in victory, some officer was generally found to vaunt it; if in failure, the commander himself would write, or inspire some other to write, the story in his own vindication. In early days, it frequently fell to a chaplain to set down the chronicle of a great war, as did D'Auvergne for William III., though Marlborough's chaplain, Hare, left only a manuscript journal instead of a printed volume behind him. The last of these historian chaplains was he who accompanied General Grey to Martinique in 1794, for after that year it must be regretfully confessed that the British became for a time something of a godless Army. Many expeditions left England without any chaplain at all, and at one moment there was only a single solitary divine to be found with Wellington's army in the Peninsula. However, failing the parson, some other chronicler generally presented himself, and did the work no worse and no better.

Once only, during the eighteenth century, did a real man of letters touch on military history, and then only through the strange chance that Tobias Smollett was serving on the fleet as a surgeon. But for him, the ghastly story of Cartagena in 1741 would be unknown. Marlborough found no historian worthy of his genius, and has not to this day. We make strangely little of Marlborough, the greatest soldier and one of the greatest men that we have ever produced. There is no statue of him in London or in Washington, though but for him England might have sunk to a dependency of France, and French would now be the language of North America. How different would his fame be if, instead of a Kane, a Millner and a Parker, there had been a William Napier in his army! Still he lives at least as a hero of Uncle Toby and Corporal Trim. Clive was more fortunate; and we should be inclined to reckon Orme's *Military Transactions in Hindostan* as our first military history worthy of the name. Colonel Newcome, as we know, delighted in it and would quote with gusto sonorous passages which are still worth reading. But outlandish names and strange words forbid Orme's work to be popular; and it is one of those classics more talked of than read.

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Orme set a fashion, however, and serious Indian campaigns until 1820 gave birth fairly regularly to more stately quartos, of which Colonel Mark Wilks' *History of Mysore* has most merit. Lord Mornington, mindful of the late Warren Hastings, took care to have a more or less official account of his Mahratta wars prepared, to ensure that his version of affairs should be the first before the public. Thus India may claim priority in producing what might almost be called a school of military history.

But who, except special students of the subject, could name any contemporary accounts of our long and almost unintermitted struggle with France, between 1742 and 1808? All that we know of the conquest of Canada we derive from the admirable works of Francis Parkman. For any account of Dettingen, Fontenoy and Minden we were dependent for years upon Carlyle's *Frederick the Great*. We have gathered from the pages of *Pickwick* that the Marquis of Granby was a hero, but it is chiefly from the German, Tempelhof, that we learn of his heroism. The finest incident in the dreary war of American Independence is unappreciated in the deadly pages of Steadman. In the bitter contest with Revolutionary France the years 1793–1801, being for the most part a tale of failure and disaster, found few and insignificant chroniclers, though three indifferent writers came forward to tell the story of the successful Egyptian campaign. Nor was it until after Waterloo that English military history at last took its place in English literature.

Southey was the first distinguished man of letters to take a military history in hand; but his volumes on the Peninsular War were promptly extinguished by those of the little-known soldier, William Napier, and that in virtue not of greater military knowledge, but, as shall presently be seen, of superior literary power. But curiously enough there was another soldier, Henry Bunbury, contemporary with Napier, and closely connected with him by marriage, who possessed striking literary gifts. He had set down his experiences from 1799 to 1810 for his own amusement and, though he had printed them privately for behoof of his friends, only published them in 1854 under the title of *The Great War with France*. Unfortunately, his active service was confined chiefly to the Mediterranean; but his masterly summary of the Army's work from 1795 onwards, and, above all, his account of the action of Maida, sufficiently show how great was his ability as a writer. It is, historically, a most valuable, as well as a most entertaining, work, but naturally secured comparatively little attention from a generation brought up on Napier.

It seems to have been mainly by chance that William Napier became a historian, for he was one of those rare men who would have distinguished himself in any profession. Physically, he was a magnificent animal, tall, deep-chested, active, with a dignity of gait which his soldiers never forgot, and a strikingly handsome face. Moreover, he had quick brains, a marvellous memory, and indomitable industry in exploring the whole field of literature. His brother officers, when he was a subaltern, believed that he could repeat by heart the whole of Pope's *Iliad* and *Odyssey*, to say nothing of other poems, which sufficiently accounts for his mastery of words, both with tongue and

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with pen. However, being the son of a soldier and brought up upon Plutarch's *Lives*, he received a commission in 1800, when he was barely fifteen, and, falling under the spell of Sir John Moore a few years later, became earnest in the study of the military profession. He had the campaigns of Hannibal, Scipio, Cæsar and Alexander at his fingers' ends, for those were the happy days when a soldier's training was still modelled upon classical example. He then served for several campaigns in the Peninsula, with great eminence for personal gallantry and tactical ability, but with no very good fortune, his best service being overlooked and his career frequently interrupted by wounds and sickness. Finally, he retired in 1820 on the half-pay of a lieutenant-colonel—£171 a year—having already a wife and a growing family, and having also a bullet lodged near his spine, which kept him always in pain and frequently in excruciating agony. The prospect was not very bright for beginning a new life at the age of thirty-five. He resorted first to painting and sculpture, giving much time to the Elgin marbles and to the study of anatomy; and he actually produced a statuette which gained commendation from Chantrey. Then Southey brought out his history of the Peninsular War; and Lord Langdale, hearing Napier's criticism thereupon, urged him to write the history of the war himself. So far, Napier had published nothing but an article on Jomini's "Principes de la Guerre," in the *Edinburgh Review*; but the fire was kindled within him, and he resolved to commence historian. This was in the year 1823.

Chantrey had predicted success for Napier as a sculptor because of his perseverance; and Napier turned with devouring eagerness to the historian's first business—drudgery. The idea was that he should write a single volume only, carrying the story to the death of Sir John Moore; but already in 1827, before he had published a line, he was warning John Murray that the work would exceed three volumes, though it would be concluded in four. Such have been the hopes and fears of many historians. The Peninsular War filled ultimately six volumes. Meanwhile, there were books to be bought, and Napier was poor; there were visits to Paris, visits to London, conversations with Soult, conversations with Wellington, endless correspondence, and finally mountains of original documents not only in English, but in French, Spanish and Portuguese. Let no man who can read these languages comfortably in print imagine that he is thereby equipped to cope with them in manuscript. Bad writing, faint ink, colloquialisms, provincialisms, solecisms and mis-spellings will soon convince him to the contrary. With all these difficulties Napier grappled manfully; and his accomplished wife not only helped him, in the leisure which she could spare from her eight children, but actually puzzled out for herself the cipher of King Joseph's letters and drew up a key to it. Wellington, when he heard of this, declared that he would have given £20,000 for such a key at his headquarters. So the two toiled on; and only those who have gone through the like labour themselves can have any idea what it means—nor can even they imagine the burden of it when aggravated by that of constant physical pain. William Napier has two distinct scripts—so distinct that they would deceive the inexpert—which tell a

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sad tale. The one is an ordinary hand, sloping to the right, as was the rule in those days, and this (to judge from internal evidence) is that which he employed when sitting at his table in comparative ease and comfort. The other is nearly vertical, a striking, peculiar, not uncomely and almost "precious" hand, which he used when lying on his back and battling against pain; and even in brief letters, written in this vertical hand, there appear the stinging epigrammatic sentences which are found so frequently in the history. It is, so to speak, his controversial or fighting script.

Six times was the first volume written and re-written before Napier's artistic sense was satisfied, and in the spring of 1828, just a century ago, it at last appeared in print. Napier's first draft apparently no longer exists, and the manuscript which went to printer (most kindly shown to the writer by Sir John Murray) is a transcription by several copyists, with corrections in Napier's vertical script; only on the first page are three drafts of the dedication, from which it seems that the characteristic allusion to Cæsar and the Tenth Legion was an afterthought. However, there the volume was, completed at last, and in a moment the work of Southey and of all other competitors was swept away from the field. No one but Napier could write the history of that war; and, encouraged by his success, he wrestled the more eagerly with his task. None who have not attempted it can conceive of the difficulty of setting down clearly and succinctly the operations of a dozen different armies and of as many guerrilla bands, and of appraising aright their significance and their bearing upon the main combatant bodies. And, quite apart from these, there were the vagaries of diverse Portuguese and Spanish factions to be followed, and the general course of military and political action to be traced and summarized, not only in England and France but all over Europe. Still, these latter came as a relief to purely military narrative, for the vocabulary of military operations is jejune and is not easily varied. It is easy to see that Napier rejoices in his freedom when he turns from military to more general topics. Nevertheless, he stands almost, if not quite, alone in the skill wherewith by sheer wealth and power of language he bursts through all the trammels of military conventional terms and carries the reader into the heart of march or combat. There is also in his narrative a tempestuous vehemence, which banishes all suspicion of labour and study painfully prolonged, of contradictory statements carefully weighed, of contending probabilities delicately balanced. All difficulty is masked by the ease of performance. He has assimilated his material and made it his own. He has shaped it to his mind, and he displays it with an Olympian majesty which takes for granted the wonder of creation. And this is great art.

A century of experience and research has corrected many mistakes in Napier's narrative, and mere time has turned the most violent of his prejudices for and against certain individuals into something very like absurdity. As to the mistakes, Napier's heart misgave him long before his death that his history was full of what he crudely called lies, but which deserve no harsher appellation than errors. He would be a bold historian who did not share Napier's despondency. But, none

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the less, it was a dangerous thing to differ from Napier, for he was as combative as William Cobbett himself, and would bring all his powers of invective and scorn to bear upon the unhappy dissentient. He appears to have been quite unaware of the injustice that he did or of the wounds that he inflicted, for he would " throw himself on the ground, bathed in tears, when he thought he had done an injury." The truth seems to be that incessant pain, reacting upon an emotional nature, produced in him almost insane extremes of fury and of grief. He collapsed in helpless weeping when his hero Napoleon died; he nearly fainted when he heard of the death of his hero Wellington; but he boiled with eagerness to defend his damnation of his villains either with pen or with pistol. His later volumes passed more or less unchallenged because (as a passage among the Gurwood Papers shows) people thought it useless, if not wrong, to argue with one who could hardly be held responsible for his words.

That torturing bullet near the spine has, therefore, much to answer for; yet it may be that it was in part responsible for some of his most brilliant passages. The most famous of all—the attack of the Fusilier Brigade at Albuera—follows immediately upon a scathing criticism of Beresford, which had wrought up the author to excitement. The description of the battle is full of mistakes. Napier was not present and had never gone over the ground; but no one will ever care to read any other. The literary art of it is marvellous. The opening words —" Such a gallant line "—are almost light-hearted, but grimness closes in upon them immediately, and deepens and thickens in a superb *crescendo* till we reach the climax :—" The rain flowed after in streams discoloured by blood, and fifteen hundred unwounded men, the remnant of six thousand unconquerable British soldiers, stood triumphant on the fatal hill." The battle is not over; there is still much to be told. But Napier, giving a final touch of art, closes his chapter with those words and leaves us gasping, unable to bear more.

Take, again, the solemn prelude to the storm of Badajoz :—

> " The night was dry but clouded, the air thick with watery exhalations from the rivers, the ramparts and the trenches unusually still; yet a low murmur pervaded the latter; and in the former lights were seen to flit here and there, while the deep voices of the sentinels at times proclaimed that all was well in Badajoz."

Napier himself was not present, and, as a matter of fact, the French sentries shouted half-hourly, " *Sentinelles ! garde à vous !* " which the British soldier translated into " All's well in Bada*hoo* " ; but Napier would not sacrifice a wonderful conclusion to a wonderful sentence for any such trifle as that. Curiously enough, the scenes which he had not himself beheld often called forth some of the noblest of his imagery :—

> " The walls of Zaragoza thus went to the ground, but Zaragoza herself remained erect, and, as the broken girdle fell from the heroic city, the besiegers started at the view of her naked strength."

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Again, at the opening of the French attack at Talavera :—

" The Duke of Belluno gave the signal for battle, and eighty pieces of artillery immediately sent a tempest of bullets before the light Troops, who, coming on with the swiftness and violence of a hailstorm, were closely followed by the broad black columns, in all the majesty of war."

Again, of the advance of the Spaniards to their doom at Ocana, " they had come down from the Morena like a stream of lava, and burst into La Mancha with a rapidity that scarcely gave time for rumour to precede them. But this swiftness of execution, generally so valuable in war, was here but an outbreak of folly. Without any knowledge of the French numbers or positions, without any plan of action, Areizaga rushed like a maniac into the midst of his foes and then suddenly stood still, trembling and bewildered."

Nor can the description of the Spanish insurrection be omitted :—

" Manifestos, decrees, and lofty boasts, like a cloud of canvas covering a rotten hull, made a gallant appearance, when real strength and firmness were nowhere to be found."

Now let us take Napier speaking as an eye-witness on the day before the battle of Salamanca :—

" . . . the night came suddenly down with more than common darkness, for a storm, that common precursor of a battle in the Peninsula, was at hand. Torrents of rain deepened the ford, the water foamed and dashed with increasing violence, the thunder was frequent and deafening, and the lightning passed in sheets of fire close over the column, or played upon the points of the bayonets. One flash falling among the 5th Dragoon Guards killed many men and horses, while hundreds of frightened animals, breaking loose from their piquet ropes and galloping wildly about, were supposed to be the enemy's cavalry charging in the darkness ; but to a military eye there was nothing more imposing than the close and beautiful order in which the soldiers of that noble light division were seen by the fiery gleams to step from the river to the bank and pursue their march amidst this astonishing turmoil, defying the storm and the enemy."

Last, let us read once more the tribute to Edward Freer, of the 43rd, after his death at the battle of the Nivelle :—

" Of two who fell in this battle I will speak. The first, low in rank, for he was but a lieutenant, rich in honour, for he bore many scars, was young in days. He was only nineteen. But he had seen more combats and sieges than he could count years. So slight in person and of such surpassing and delicate beauty that the Spaniards often thought him a girl disguised in man's clothing, he was yet so vigorous, so active, so brave, that the most daring and experienced veterans watched his looks on the field of battle, and implicitly following where he led, would like children obey his slightest sign in the most difficult situations. His education was incomplete, yet were his natural powers so happy, that the keenest and best furnished intellects shrunk from an encounter of wit, and every aspiration was proud and noble, indicating future greatness if destiny had so willed it."

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Indeed, whether William Napier writes from his brain or from his heart, he is incomparable. It is easy to point out the blemishes in his work, the controversial and aggressive tone, the frequent cumbrous quotations, the extravagant partiality of some personal opinions, whether for or against; but the *History of the Peninsular War* is one of the military histories of all time. He had fought through it as a regimental officer and knew it, so to speak, as a pawn. He had so deeply studied his profession that he could judge of it also as a player, and indeed was sometimes treated as such by Wellington himself. He knew private soldiers and he knew strategists, and realized that both alike were men and playthings of fortune, not the arbiters of their own destinies. Outside his military experience he was endowed in the highest degree with the historian's most precious gift—imagination—and he had strengthened it by wide and deep historical reading. Like Leonardo da Vinci, who was only incidentally a painter, however great, Napier was only incidentally a soldier. He loved his humbler companions in the service passionately, and never lost his interest in military questions, but the range of his intellect spread far beyond such bounds. Had he entered political life, he would have made his mark; for he could speak as eloquently as he could write, and would have left behind him epigrams akin to those which are so frequent in his history. "Men and not mountains decide the fate of a battle." "The bustle of confusion is easily mistaken for the activity of business." "The indecision from which none but great men and fools are free." "A memorable tale and a ruined city," and the like. But happily he resisted all pressure to stand for Parliament. Eloquence is but a branch of the dramatic—an interpretative art; and Napier was born to be a great creative artist. Whatever the passions which may have inspired him to resort to the pen for self-expression, he was too conscientious not to search earnestly for the truth and to set it forth becomingly as in his heart he believed it to be. Seventeen years of drudgery and grinding toil, with the bullet near the spine never resting in its work of anguish, went to the making of the six volumes. He knew all the troubles of an artist.

"Easy ys myne boke to rede and telleth of moche fyte,
But then your easy rede is damned hard to wryte,"

he wrote, in parody of Chaucer, when the work was done. But he has left us an everlasting possession.

THE STORY OF THE ROYAL REGIMENT OF ARTILLERY.

By Lieut.-Col. C. A. L. Graham, D.S.O., R.A., *p.s.c.* Assisted by Officers of the Regiment. Royal Artillery Institution, Woolwich, 1928. (Price, 8d. post free.)

This handy and well-illustrated little book of about 100 pages, bound in thick paper covers and priced at eightpence, post free, is designed for soldiers preparing for the Second Class Certificate of Education; material on which instruction for Third Class Certificates can be based being marked by a line in the margin. The cover design includes the Regimental badge and mottoes, and the zig-zag red and blue colours of the Royal Artillery. The book is divided into ten sections, the first

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being devoted to the history of Artillery before the formation of the Regiment in 1716. The Campaign of Waterloo, the Indian Mutiny, the South African War, and the Great War, have a complete section devoted to each campaign.

General Sir George F. Milne, Colonel Commandant, R.A., contributes a foreword in which he stresses the importance of battery histories. "In this book," he writes, "nothing more than a general survey has been attempted; the real regimental history of the Royal Artillery is the history of the battery. This story has been written to provide batteries with a setting for their own exploits and to enable the more recently raised batteries to study the deeds of the Regiment in those countries in which they are serving or have served."

We have nothing quite like this book in the R.E. *The Deeds of the Royal Engineers*, compiled in the Record Office during the War, might usefully be revised and brought up-to-date on the lines of this attractively got-up short history of the Royal Artillery.

B.R.W.

THE SHAKESPEARE MYSTERY.

By GEORGES CONNES, Professor of (English) Literature at the University of Dijon. Abridged and translated into English by a member of the Shakespeare Fellowship.

(Cecil Palmer). Price 7s. 6d.

The Shakespeare Fellowship, of which Colonel B. R. Ward, C.M.G., is Honorary Secretary, a "brotherhood of all lovers of Shakespeare who are dissatisfied with the prevailing Stratfordian orthodoxy," has translated and published, with an original Preface, ten out of twelve lectures delivered by Professor Connes in 1925, in which he reviewed the various opinions held in the present day on the authorship of the works attributed to Shakespeare. After a brief historical sketch of the days of Elizabeth, the Professor describes in full the claims of orthodox Stratfordians, and of those who ascribe the works to Francis Bacon, Viscount St. Albans, to Roger Manners, Fifth Earl of Rutland, to William Stanley, Sixth Earl of Derby, and to Edward de Vere, Seventeenth Earl of Oxford. In each case he writes as a convinced advocate of the claim under discussion, so that a reader who may approach to the subject with an unbiased mind may here find an introduction to the arguments maintained by each party, and draw his own conclusions. In his concluding chapter the Professor gives it as his opinion that Shakespeare himself is the author . . . "as Bacon said, if a little knowledge takes man away from God, a deeper knowledge brings him back to Him. And similarly, if a superficial study of the Shakespeare problem takes one away from Shakespeare, an extended study brings us back to him." The writer of the Preface claims that Professor Connes' summing up is far more than a mere echo of the earlier Stratfordian apologists. "By admitting the relations between William Shakspere of Stratford with Oxford, Derby and Rutland, he has placed an entirely new complexion on the Stratfordian case." Those who turn to the book to discover what this is will be well rewarded, for there is not a dull page in it. Few translators have been more successful in concealing their art than this "Member of the Shakespeare Fellowship."

F.E.G.S.

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THE WORLD CRISIS. BY WINSTON CHURCHILL: A CRITICISM.

By Lord Sydenham, of Coombe, Admiral Sir Reginald Bacon, Major-General Sir Frederick Maurice, Major-General Sir W. D. Bird and Sir Charles Oman. (Hutchinson & Co., Ltd. 10s. 6d. 1927.)

This book should be read by all those who have read Mr. Winston Churchill's *The World Crisis*. In a review in the *R.E. Journal* by the present writer, it was pointed out that readers of those volumes should not permit themselves to be carried away by the literary gifts of Mr. Churchill, or be deceived by the specious arguments of that illustrious politician. Mr. Churchill no doubt takes pains to obtain correct facts and correct figures, but it is the way in which he uses those facts and figures to serve his purpose that vitiates the value of his chronicle of the War. Colonel Lord Sydenham (Sir George Clarke, late R.E.) discusses "Mr. Churchill as Historian." Sir Charles Oman, late Chichele Professor of Modern History at Oxford, and during the War in charge of the Department that dealt with German losses, disputes the figures on which Mr. Churchill based his arguments in the chapters of his book, entitled, "The Blood Test," and "The Battle of the Somme." Major-General Sir W. D. Bird puts forward some opinions from other points of view than Mr. Churchill's as to the strategy of the War, especially with regard to the initial plans of concentration, and also discusses the question of losses. He quotes Ludendorff's opinion that:—"The "modern defensive battle is more costly than the attack, one reason "more in favour of the latter . . . losses (in attack) consisted mainly "of slightly wounded men who came back. The prisoners we lost in "the defence had to be struck off for good." Mr. Churchill, it will be remembered, wrote:—"In all the British offensives (founding his "conclusions on official figures), the British casualties were never less "than 3–2, and often nearly double the corresponding German losses. ". . . Whereas while the British suffered heavier losses in all offensives "they exacted more than their own losses when attacked by the Germans "in 1918." Mr. Churchill's deduction is the opposite of General Ludendorff's! He advocated withdrawal and defence, and tried to show that every attack was bound to fail, until, of course, his Ministry of Munitions had time to provide us with an overwhelming superiority of tanks in 1919. Major-General Sir Frederick Maurice discusses Joffre, Gallieni and the Marne, and shows how Mr. Churchill based his praise of Gallieni entirely on a fiction. He champions Marshal Joffre, and shows how he, and not Gallieni both planned and won the Battle of the Marne. The final and the most interesting chapter is that on Jutland by Admiral Sir R. Bacon. It may not be "the last word" on Jutland, but it shows that Mr. Churchill based his conclusions on facts that were not all facts, and how unfair those conclusions were to the Commander-in-Chief of the Battle Fleet, and to the Admiral commanding the 5th Battle Squadron. "It is often difficult," he says, "to follow Mr. Churchill's arguments because of the inaccuracies they contain." In discussing Mr. Churchill's views of what Admiral Jellicoe should have done, he points out "three inaccuracies—the speed of the armoured cruisers is "incorrect, the number of *Carolines* with the C.-in-C. is mis-stated, the

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" time at which the armoured cruisers were sent forward was not 'at " the first alarm,' but fifty minutes after the first alarm. But the " really important point that emerges, is that the whole of Mr. Churchill's " elaborate argument, as to what the C.-in-C. should have done, is " based on an inaccurate estimate of the speed of the armoured cruisers, " and an oversight as to the position of the 3rd Battle Squadron " at 3.10 p.m." This is only one instance ; Sir R. Bacon gives several others, and he provides excellent sketch maps to show the position of the fleets at the crucial moments.

It is fortunate that this " criticism " of Mr. Churchill's book has been written, and by such distinguished writers. Untold injustice has been done by *The World Crisis*. That can now never be undone, but it is well for history that the facts should be recorded before all those who took part in the battle have passed away.

H.B-W.

CALLINICUS: A DEFENCE OF CHEMICAL WARFARE.

By J. B. S. HALDANE.

(Price, 2s. 6d.)

The author, who was Reader in Bio-chemistry at Cambridge, develops the two conclusions, that use will be made of chemical weapons in future large wars despite or because of existing agreements on the subject, and that such means will not make the results of fighting any more painful or cruel than the more usual methods which for years have passed the censorship of decent behaviour.

Indeed, the use of lachrymatory gas may be said to be the gentlest way of waging war that has ever been thought of. Though mustard gas caused about 150,000 casualties in the British Army alone, less than 4,000 (say 1 in 40) died, and only about 700 (say 1 in 200) became permanently unfit. Mustard gas, therefore, kills one man for every forty it puts out of action, while gunfire kills one for every ten.

Moreover the type of wound caused by a shell is far more distressing than the worst type of gas pneumonia.

The writer, or rather lecturer—for the origin of the little book was a lecture given at Mürren—claims that the use of mustard gas in war on the largest possible scale would render it less expensive of life and property, as well as shorter and more dependent on brains than on mere numbers. The most effective defence against gas is education, the education of all classes of our population.

Amongst all humanity there is a very definite natural terror of the unknown, and it is greater in inverse proportion to the current standard of education. The thought of poison gas produces one of the most alarming of these phobias.

During the Great War, large numbers of unnecessary casualties were caused during the early stages of gas attack, because trust was placed in certain so-called protectors sent out to soldiers by their friends at home, rather than in the more effective but less satisfactory-looking masks issued by the Army authorities.

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A further terror was added by a widely-accepted rumour, that the survivors of lung-irritant gases would get consumption, while those burned by mustard gas would develop cancer; these predictions have not proved true, but the proof could not be broadcast at the time.

Such warfare can only be combated by a scientific study of causes, and a special type of accurate thinking.

"During the Great War, twenty-five different poisonous weapons "were employed; of these, three are gases at ordinary temperatures "and can be discharged from cylinders in which they are stored under "pressure. The remainder are liquids which gradually evaporate, "yielding a poisonous vapour or solids which are poisonous in the form "of smoke.

"The wonderful gas, which would put the enemy to sleep and allow "him to be taken prisoner comfortably, does exist, but is not a working "proposition, because the concentration has to be too exact for practical "possibility. One has only to think of the familiar case of chloroform "vapour and the skill required to give neither too much nor too little."

Discussing the possibility of an aerial gas bombardment of London, the writer considers that the effect in civilian casualties, provided the civilians had previously been educated in the mysteries of gas warfare and were provided with protectors, would be almost infinitesimal, compared to a bombardment with explosives by a similar fleet. Besides which, the material damage of the former is practically nil. Its real danger would arise from the effects of panic.

The author then presents a thesis for the tactical use of chemical weapons in the future. "The main efforts of the soldier who uses "them will be devoted, first, to blistering his enemy, and secondly, to "tiring him out by forcing him to wear a respirator continuously, "which, of course, enormously hampers him for doing anything else."

Mustard gas was used to make large areas absolutely untenable by the defenders, though it had the disadvantage that the attackers could not enter the forbidden zone either. It persists as a great danger for about a fortnight. But it is such an effective and reliable weapon that the difficulty will be evaded by some means. The attackers will either be immune by nature or be rendered immune by covering and they could be assisted by air-tight tanks. Either the effect will be avoided by clothing the attackers with a complete air-tight outfit, together with gas mask, or use will be made of men who are physiologically immune to its effects. One attack of gas poisoning does not, unfortunately, confer immunity against a second dose.

That some are immune by nature was made patent in the trials and tests carried out by the American Army. This resistant class comprised some 20 per cent. of the white men tested, but no less than 80 per cent. of the negroes. In explanation of this interesting fact, he shows that the blistering effects of mustard gas and the sun are very similar, and the negro is known to be practically immune to the latter. Probably by the same reasoning, Indian troops would be as immune as negroes. It would seem, therefore, that enough coloured troops could always be obtained to provide a sufficient and efficient shock formation, together with enough resistant whites to officer them.

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One sees, then, the possibility of warfare somewhat on the following lines :—

"Heavy concentrations of artillery would keep an area, say, thirty "miles in length and ten in depth, continuously sprayed with mustard "gas. After allowing, say, two days for the development of blisters, "the gassing of the positions within two or three miles of the first "line is discontinued, but a long range bombardment, especially of "roads, goes on. Suddenly, behind the barrage appears a line of tanks "supported by negroes in gas masks. They meet with little opposition "in the area still reeking with gas, and occupy the hostile lines to a "depth of two or three miles. A counter-attack, even if successful, "involves concentration in an area under gas bombardment and enor-"mous casualties from blistering. The only satisfactory counter-attack "would be from the air. In this way, the side possessing a big superior-"ity of mustard gas and immune troops should be in a position to "advance two or three miles a day."

These methods introduce more strategic and administrative complications, but would establish and maintain a war of movement leading to more rapid decisions with far fewer casualties on either side.

It is to be remarked, at present, that Germany is devoid of coloured troops.

Gas warfare thus seems to be more humanitarian than the other forms. It may be asked, however, whether gases of the future may not be more cruel than those of the past. "Only a limited number of "chemical substances are appreciably volatile, and of their vapours "only a small proportion are poisonous. Now, every chemical sub-"stance has a definite molecular weight. Those with small molecular "weight are on the whole the most volatile. Now, the large majority "of the possible volatile chemical substances of small molecular weights, "and therefore relatively simple chemical composition, are already "known. Mustard gas, for example, was discovered and its properties "described in 1886. There are probably substances of high molecular "weight, whose dense vapour is even more poisonous than mustard "gas. But the charcoal of our respirators has the property of absorbing "heavy molecules of vapour quite independently of their chemical "composition. It is, therefore, somewhat unlikely, though not of "course impossible, that any very poisonous vapour will ever be found "which will go through a mask impermeable to mustard gas or chlorine. "It is, to my mind, far more probable that skin irritants may be dis-"covered, which are even more unpleasant than mustard gas."

Chemical weapons are roughly divided into four distinct classes. First come gases and vapours which are poisonous when breathed, but which have no ill effect on the skin and only affect eyes and nose when present in concentration heavy enough to be harmful to the lungs. Such are chlorine and phosgene. A second group, the lachrymatory gases, are deadly only in very high concentrations, but have an intense irritant effect on the eyes even in minute quantities. It is believed that this group caused no deaths or permanent blindness. Both these groups can be kept out by respirators.

The third group consists of the blistering gases, of which dichlorethyl

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sulphide or mustard gas is the type. It is really a slowly volatile liquid and is extremely effective. " A drop of the liquid was put on a piece " of paper and left for five minutes on a man's sleeve. The vapour " penetrated his coat and woollen shirt, causing a blister, the effects of " which lasted six weeks."

The fourth series consists of poisonous smokes, mostly arsenic compounds, and were little used, though they were being developed for the 1919 campaign. They are extremely distressing temporarily, yet the large majority of casualties would recover in two or three days, and none who were previously fit would become permanent invalids.

" It is not unlikely that concentrations of smoke will be produced in " the future which will penetrate our present masks. If our anti-gas " measures are sufficiently neglected, the consequences may be serious."

Smoke particles are moving many thousand times less quickly than the molecules of gas ; the former are, therefore, more likely to be drawn through the narrow passages in the filter without colliding with the absorbent walls. It will be easily realized that to make these passages more restricted still, would make such a resistance to breathing that the protector would become impracticable. For this reason, smokes may become more dangerous than the blistering gases.

It is of interest that the author's opinion as to the comparatively humane results of gas warfare are borne out by a President Physician-in-Chief of the large American gas hospital at Toul, during the Great War (*vide R.E. Journal* of March, 1924, p. 178).

D.M.F.H.

THE AUSTRALIANS AT RABAUL.

The Capture and Administration of the German Possessions in the Southern Pacific. By LIEUT.-COL. S. S. MACKENZIE. (Sydney: Angus & Robertson. 30s. net. 1927.)

Rabaul, on the shores of Blanche Bay at the north-eastern extremity of the large island of New Britain in the Bismarck Archipelago to the north of Australia, is the British, as it was the German, seat of Government of the mandated territories, formerly known as the " old Protectorate," which include German New Guinea. It is destined to be a pivotal point in the Pacific, on account of its position and excellent harbour, known as Simpson Harbour. This volume forms Vol. X of the *Official History of Australia in the War of* 1914–18, and is written for Australian readers and as a text book for Australian youth. But it contains a great deal of information which is of interest to all who aspire to understand the problems of Empire, for it throws light on British Colonial Policy in the 'eighties, explains how Germany came to get a footing in the Southern Pacific, and helps us to understand the Australian point of view in regard to what was looked on by Australians as a betrayal of their birthright.

On August 6th, 1914, the following telegram was addressed by the Secretary-of-State for the Colonies, in cypher, to the Governor-General

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of Australia:—"If your Ministers desire and feel themselves able to "seize German wireless stations at Yap, in Marshall Islands, Nauru on "Pleasant Island and New Guinea, we should feel that this was a great "and urgent Imperial service. You will, however, realize that any "territory now occupied must be at the disposal of the Imperial Govern- "ment for purposes of an ultimate settlement at conclusion of the "War . . ." In view of the heart-burning caused in Australia in 1884, by the complacence with which the occupation by the Germans of the Old Protectorate, was apparently regarded in England, it is not surprising to read that an expedition was organized, within a few days of the receipt of the telegram, to seize these German colonies. It was under the Command of Colonel W. Holmes, afterwards Major-General Holmes, C.M.G., D.S.O., V.D., who was killed in Flanders on 2nd July, 1917, while commanding the 4th Division of the Australian Expeditionary Force. There was not much fighting, but both in the fighting and the subsequent administration of the captured colonies, the Australians showed the same qualities of initiative and resource which their brothers-in-arms showed in Gallipoli, France and Palestine. The proviso in the telegram of the Secretary of State for the Colonies, quoted above, laid the obligation for the administration of the captured territories on Australia, and it was no easy task to deal with the German colonists and the large native population with the uncertainty whether the colonies were to revert to Germany or become British after the War. A large part of the book is devoted to the details of administration and the methods by which the difficulties of government were overcome. It was Australia's first attempt to carry out an expedition depending entirely on its own resources, and although mistakes were made, the results were successful, thanks firstly to Colonel Holmes and later to Brigadier-General Pethebridge who succeeded him. One of the chief lessons learnt was the futility of short enlistments. The whole of Holmes' Force soon became time-expired and had to be relieved by newly-enlisted men, who were organized in what was known as the "Tropical Force." There was also a serious breakdown in the continuity of supplies wherewith to feed not only the troops but also the native inhabitants, the usual sources of supply and means of water transport having been interfered with by the War. The lessons have fortunately been recorded, and this volume will be of value when Australia is again called on to take her share in any struggle in which the British Empire may be involved. It is interesting to note that Japan and not Australia eventually occupied not only Yap, but the whole of the Marshall Islands, and also the Marianne, Pelew and Caroline groups, and, at the signing of the Peace Treaty, Japan was given the mandate over all these islands. The "mastery of the Pacific" is very much in the air at the present time, and to anyone who is interested in the subject this volume will be invaluable, if only for the history and geography of the Southern Pacific Islands which it contains. The book is well illustrated and copiously supplied with maps and sketches, and has a good index.

H.B-W.

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LA VALLATA DELLA GIUBA.

By COMANDANTE G. B. CARNIGLIA.

This book is an official publication of the Government of Italian Somaliland, and is one of a series of monographs on various districts in the country. It deals with the River Juba and its valley, from Dolo, near the Abyssinian border, to the coast at Jumbo, near the port of Kisimajo, and is the report of a mission carried out by the author in the winter of 1925–26, with the object of obtaining information on the following points: navigability and volume of flow of the river, feasibility of damming and irrigation, possibility of development of harbourage and port facilities at the mouth, verifications of the map produced by a previous mission in 1923–24.

The time at the disposal of the author was the period from autumn to late spring, and he was the only white man of the party. The distance from the coast to Dolo and back, as he travelled it, is over 1,600 km., so not a very detailed examination was possible. The author seems to have got through a very large amount of work in the time, however.

A description of the river and its valley is given from the Abyssinian border to Bardera, the chief town inland, and thence on to the sea. In the former part, the river runs in what is really a cleft in a sparsely populated plateau. South of Bardera, it runs in a broad flat valley with marshy land on each side of it. Water from the river flows into these marshes (known as *deschek*) through natural channels, and the native population is concentrated round them. The channels are used by the natives to control the flow of water for irrigation, cultivation being confined to the edges of the *deschek*. Through ignorance and mismanagement, however, misuse of these channels frequently leads to flooding of the cultivated lands. The author points out the need for careful study of the behaviour of the river in flood and for official control of the irrigation channels.

The possibilities of barrage and irrigation schemes are examined, but, without more exact topographical knowledge, nothing really definite can be proposed. General lines of progress, however, are suggested, including a dam above Marriento to irrigate the higher land.

Measurements of the volume of flow at Bardera were made and are tabulated. The flow varies very greatly—from about 1,043 cub.m./sec. down to less than 60, according to the season.

Proposals are worked out for the conservancy of the river mouth to enable coasting steamers to use it; also for the improvement of the port of Kisimajo, some little distance down the coast, by building there a small breakwater to shelter lighters, tugs, etc., and by the construction of a Decauville line connecting it with Gobuin at the mouth of the Juba.

The river is navigable as far as Bardera, 600 km. up-stream, for about one-half of the year by tugs and lighters drawing 70 cm. Native water transport by dhow is declining, however; this leads to decline also of the river trade among the natives themselves. North of Bardera, no river traffic at all is possible.

As regards the exploitation of the valley as a whole, the author

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suggests cattle-grazing in the northern uplands, though the difficulty of transporting the produce to market is admitted, there being neither road, rail nor river transport available. On the plains in the south, maize and sesame are grown, but the native is improvident and lacks perseverance. Control of the natural irrigation channels, however, by minimizing the danger of floods in the cultivated areas, would do much to stabilize the villages and their inhabitants. The development of artificial irrigation would go still further to improve matters. Labour, however, is a difficulty in the way of extensive developments, and it might be necessary to import it from other places in Africa. The country is not, of course, suited to colonization by European emigrants.

There are no natural resources in the valley of minerals or timber.

The book is illustrated by a certain number of photographs, not very well reproduced, and by twenty-four maps, plans and diagrams.

V.D.

THE SEVENTEENTH EARL OF OXFORD, 1550–1604. By B. M. WARD.

(John Murray. Price, 21s.)

In 1920, Mr. J. T. Looney published his book *Shakespeare Identified*, in which he claimed the authorship of the greater number of the plays and poems attributed to Shakespeare for Edward de Vere, 17th Earl of Oxford. Since that date, The Shakespeare Fellowship, of which Colonel B. R. Ward, C.M.G., is the enthusiastic secretary, has been investigating the history of this little-known and much-maligned nobleman. The results of these enquiries are now published in this scholarly biography by B. M. Ward, which will be read by many, beyond those who are interested in Mr. Looney's theory, as presenting an interesting picture of an eccentric nobleman who was undoubtedly prominent at the Court of Queen Elizabeth, and throwing light upon the characters of many prominent men, especially on that of Lord Burghley, whose daughter was married to the subject of the book.

The Earl of Oxford was famous among his contemporaries as a poet and dramatist, but all his works, with the exception of a few early poems, have been lost. He has been handed down to history chiefly on account of his ill-temper, his ill-treatment of his little countess—which was reputed to have been done in retaliation upon Lord Burghley for the execution of the Duke of Norfolk, a relative of Oxford, a few months after the wedding—and his quarrel with Philip Sydney in a tennis-court, during which he called that future paladin a puppy. These and other delinquencies have been fully enquired into by Mr. Ward and Lord Oxford's life-long friendly relations with Lord Burghley are established, but the most interesting discovery about Lord Oxford, which is now first made known to the world, is that for the last eighteen years of his life, from 1586 to 1604, he received an annuity, extraordinary both in nature ("Our pleasure") and value (£1,000), first from Queen Elizabeth and, after her death, renewed in the same terms by her successor, for some "office," the nature of which is not divulged in any of the original documents. Mr. Ward discusses at length the possible

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nature of this office. "Elizabeth was the last person in the world to scatter largess around without expecting any return." There is ample evidence of Lord Oxford's interest in the drama and his intimate connection with the players and their "masters." In his later years, he appears to have had few other interests, but during those years he is known to have been closely associated with his son-in-law, William Stanley, sixth Earl of Derby, for whom, from a different standpoint, Professor Lefranc, of the French Academy, has claimed the authorship of the Shakespeare plays. Mr. Ward comes to the conclusion that Oxford "was instrumental by means of his brain, his servants and his purse in providing the Court with dramatic entertainment," and leaves it at that. We hope that The Shakespeare Fellowship has not said its last word about this mysterious personality.

F.E.G.S.

ERRATUM.

In the March, 1928, *R.E. Journal*, page 160, instead of the initials "A.P.A.L." appearing after the review of "Elements of Machine Design" the contributor's name should read "A. G. Gadd."

MAGAZINES.

REVUE MILITAIRE FRANÇAISE.

(*January*, 1928).—Commandant Roques begins "*L'organisation du terrain d'opérations de Champagne pendant la guerre mondiale*" in this number. His intention is to draw a number of important lessons from the organization of a sector, and that of Champagne is taken as an example. This instalment is devoted to a very brief outline of active operations in Champagne throughout the Great War.

L'artillerie antiaérienne, son emploi, son organisation, by Commandant Vauthier, is written to show that anti-aircraft gunnery is not so complicated as is generally thought. To the layman, Commandant Vauthier makes out a good case for his theory, but he barely touches on the intercommunication problem, which is probably far more difficult to overcome than the problem of firing with reasonable success at hostile aircraft. The writer gives his estimate of the anti-aircraft artillery required in a division, army corps and in reserve, and he considers that three types of weapon are essential, viz., a powerful gun for reserve formations, a light gun for working in divisions, and a kind of pom-pom for working either with the infantry or in defence of certain special localities.

Commandant Maury completes *La 2e division d'infanterie de la Garde prussienne les 21 et 22 août 1914* in this number. The outstanding feature of the 22nd was the retirement of the division, suddenly ordered by the Corps Commander on inadequate information, across the Sambre. As the French were also retiring, this lapse was put right without difficulty, apart from a certain amount of disorder. What stands out from these operations was that the artillery of 1914 could not afford sufficient

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support to infantry, who had to attack concealed positions defended by machine-guns.

La question de Tanger is an interesting article on the situation in Tangier, by Commandant Galy. The history of Tangier is first traced throughout the ages; the writer then describes the negotiations leading up to the statute of 1923; and finally the existing situation is indicated. The whole question is very complicated and cannot be described here; but it seems a great pity that Spain rejected the 1923 agreement and that Italy became involved at the same time. Fortunately, Great Britain and France have stood together recently over this question, and it is to be hoped that it will be finally settled fairly soon.

In the third instalment of *Au Maroc français en* 1925, by Capitaines Lacau and Montjean, it is difficult to follow the preliminary operations undertaken to restore the situation, on account of the indifferent sketches. A very interesting account is given, however, of the administrative measures taken to regroup the Army, so that the C.-in-C. could undertake the major offensive, which had to be developed before the autumn rains. It was this reorganization which laid the basis for eventual success.

(*February*, 1928).—In the second instalment of *L'organisation du terrain d'opérations de Champagne*, Commandant Roques describes the enormous improvement in communications by road and rail and the provision of railheads and depots of all kinds, carried out after the stabilization of the front in 1914. This does not make very interesting reading, but the article provides a useful study for those interested in transportation requirements during position warfare.

Colonel Armengaud begins an important article, entitled *Les enseignements de la guerre marocaine en matière d'aviation*, in this number. Apparently, the French air forces were of the utmost value in Morocco, both for offensive operations and in assisting the covering troops, and the writer has deduced some very useful lessons from the way in which they were employed. His first point is that air squadrons, except for S.S. fighters, should be equipped for instantaneous work on the outbreak of war, even though they have to be separated for a short time from most of their ground equipment. It is contended that this can be done by the addition of a couple of load-carrying machines to each squadron. Granted this organization, aircraft can be quickly concentrated for what is the main operation of war, *concentration of superior force at the decisive point*, with a minimum of delay. The writer then discusses the value of aircraft to replace a proportion of the covering troops and the organization required for the command of air forces.

In the fourth instalment of *Les victoires serbes en* 1914, Lieutenant-Colonel Desmazes and Commandant Naoutmovitch describe the Serbian offensives in the Banat and in Bosnia, followed by the Austrian decision to return to the attack. Owing to lack of war material of all kinds, the Serbs were unable to prolong any offensive operations. The Austrian C.-in-C. on the Balkans front managed to free himself of the control of Conrad, the Austrian C.G.S., and the second Austrian offensive is described in the next instalment.

The third instalment of *Au Maroc français en* 1925, by Capitaines Lacau and Montjean, describes the offensives in the Beni Zeroual dis-

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trict and in the eastern sector, the latter being designed to join up with the Spanish. The operations are described in great detail, and extra illustrations are provided by oblique aeroplane photographs. These operations definitely restored the situation on the French front.

Les événements de Chine, by Commandant Girves, is a short description of events in China from April to December, 1927. The article opens with the part played by the Russians under Borodin, and closes with the recapture of Canton by Chiang-kai-Sek and the final expulsion of the Russians. In conclusion the writer points out that the Russians, like everyone else, have failed really to make friends with the Chinese and so have failed to consolidate their original successes. He also considers that there is little hope in the dominion of Chang-Tso-lin in the north for the final pacification of China. In fact, there appears to be no immediate solution.

(*March*, 1928).—In the third instalment of *L'organisation du terrain d'opérations de Champagne*, Commandant Roques describes the special administrative measures taken before the great attack of September, 1918. A wealth of detail is given, and the article shows very clearly what an enormous amount of work has to be done behind the front line before a big attack can be developed under trench warfare conditions.

Capitaines Lacau and Montjean, in the third instalment of *Au Maroc français en* 1925, describe the operations undertaken after the autumn rains set in and the administrative difficulties of the campaign, together with the measures taken to overcome them. Marshal Pétain, the C.-in-C., saw clearly that matters must not be allowed to rest after the French successes at the end of the summer, but the problem was how to continue the pressure on Abd-el-Krim and his tribes during the winter, when the native was at a great advantage as compared with the European. The solution, brilliantly conducted by General Naulin, was the continuation of pressure by loyal native troops, combined with the use of every effort to pacify any wavering tribes. As a result, Abd-el-Krim found his position getting weaker and weaker during the winter, while the French were able to prepare for joint action with the Spaniards in the following spring.

L'action de guerre et le chef is a study by Commandant de Gaulle on the qualities of the higher command. It is written in order to draw attention to the difficulty in peace-time of training higher commanders for war, and many familiar examples are given of the failure of commanders to impress their personality sufficiently on their subordinates to keep the action of the latter within reasonable limits of control.

The fifth instalment of *Les victoires serbes en* 1914, by Lieutenant-Colonel Desmazes and Commandant Naoumovitch, describes the Austrian advance and capture of Belgrad in November. The Serbian command, however, managed to withdraw the army without serious loss, and were only waiting for an opportunity to counter-attack on a large scale. The description of this counter-attack, which cleared the invaders out of the country, is left to the next number. The main difficulty the Serbs had to contend with was lack of material, and it was essential for them to gain time before launching their counter-offensive.

The second instalment of Colonel Armengaud's important article

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Les enseignements de la guerre marocaine en matière d'aviation deals with the proportion of air forces to other arms required in the field, and the action of air forces. He finds that a far greater number of squadrons than is at present available is required for wars in uncivilized countries, but realizes that the proportion would have to be cut down in a Great War. The lesson from the Rif campaign is that air operations should be intimately connected with land operations, under which circumstances they have the maximum effect.

The writer concludes the instalment with the theory that "Air forces of the line" are required, which are not specialized, but can undertake a variety of tasks as required.

Les travaux de campagne dans l'armée allemande, by X., is a short study of the methods adopted in Germany to maintain the science of field works in peace-time. Being convinced that field works are a necessary corollary to both offensive and defensive action, the General Staff has allotted about £300,000 to this type of work in 1928.

H.A.J.P.

REVUE DU GÉNIE MILITAIRE.

DECEMBER, 1927, TO FEBRUARY, 1928.

(*December*).—Captain Jacquemin contributes an article on the construction of a pile bridge at Agde, over the Hérault, in April, 1927. It was built to provide a temporary means of communication whilst a permanent bridge was being constructed to replace an old suspension bridge. It was 66 metres long, and 6 metres wide, allowing for a double carriageway and two footpaths. There were eight piers and each pier consisted of six piles. Steel girders were used as roadbearers over four bays, wooden beams being used for the remainder. The pile-driver was carried on a lighter.

An article by Captain Bruder gives an account of the construction of a pile bridge for heavy loads over the Wadi Mellah in Tunis by the 34th Battalion of Engineers in 1926. The bridge was 28 metres long, containing six piers, each of five piles.

(*January*).—This number contains the first part of an article called "Repair of Communications," by Lieut.-Colonel Bailly. In Chapter I(*a*) he discusses the repair of roads at the opening of a campaign, in (*b*), during a battle against a fortified front outside the zone of destruction but subject to severe artillery preparation. He gives examples drawn from the Battle of Champagne on September 25th, 1915, the Battle of Malmaison on October 23rd, 1917, and the Battle of Champagne on September 26th, 1918. In (*c*) he discusses the question in the case of an attack on a fortified front, behind which lies devastated country. He gives interesting examples of works carried out within the zone of the 10th Corps during the German retreat in March, 1917.

Colonel Beyer contributes the first part of an article on the "Sieges of Przemysl, 1914–1915." It consists of translations of articles published in the *Militärwissenschaftliche und Technische Mitteilungen* by Major Stuckheil, preceded by remarks on the defence of Galicia and Bukovina in general and of Przemysl in particular. The Russians invested that place for the first time on September 24th, 1914, and retreated on October

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8th. It was again invested on November 8th, 1914, and fell on March 22nd, 1915, after an attack lasting four days. Major Stuckheil only deals with the period of armament between August 2nd and September 23rd, and with the second investment. To complete the picture, Colonel Beyer has drawn on the narrative of General Schwalb, who was Director of Engineers at Przemysl, which was published in 1918 under the title of "Defence of Przemysl, 1914–1915."

The article is written in considerable detail, and contains Tables showing the state of the garrison at various stages.

(*February*).—This number contains the last part of Lieut.-Colonel Baills' article on "Repair of Communications." There are ten photos of temporary bridges. In Chapter II he briefly describes the repair of the railways, Roye–Chaulnes and Chaulnes–Ham–La Fère, in 1917.

The article on the Sieges of Przemysl is continued by a translation of Major Stuckheil's articles, referred to above.

A.H.B.

REVUE MILITAIRE SUISSE.

(1927. NOS. 7 TO 12 INCLUSIVE.)

L'État-major russe au début de la guerre européenne. This article appears in No. 8, and is contributed by Colonel Feyler, who has brought together from many sources, some of which are enumerated, information concerning the difficult position in which the Russian General Staff found itself, towards the end of July, 1914, owing to the Austro-Serbian situation. The problem it was faced with was whether, at this time, a partial or a complete mobilization of the Russian Army should be ordered. The military situation in Russia was complicated by the fact that, both in its political and military circles, a strong desire existed not to provoke the hostility of Germany, although there was no intention in these circles to allow Austria to crush Serbia. Yet, it was felt that if Germany put her Army on a war footing, the complete mobilization of the Russian Army could not be avoided. The difficulties of the Russian General Staff were further increased owing to the uncertainty created in the situation by the British efforts to prevent the outbreak of hostilities, and also by the indecision of the Czar. The various steps taken in Russia to deal with the situation are briefly set out in the original article.

Notre défense nationale d'après l'expérience de la guerre mondiale. This article in No. 9 was contributed by Colonel Sprecher von Bernegg (since deceased), who calls attention to the fact that the neutrality of Switzerland is a voluntary one and self-imposed by its people, and consequently differs from the "guaranteed" neutrality of Belgium, which the Great Powers had by Treaty undertaken to respect. The Swiss are naturally anxious that their country and its people shall never pass through experiences similar to those undergone in Belgium in 1914 and the four subsequent years. During the Great War, the belligerent neighbours of Switzerland attached an equal value to the maintenance of its neutrality; no doubt largely because they were practically equally matched, and certainly also because they were aware that the Swiss people were ready to range themselves against the Power that should

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first violate their territory and possessed an Army capable of playing an effective *rôle* on whichever side it might come into the field. Hence, Switzerland did not in those years experience the inconveniences of war. That Switzerland can still maintain its neutrality and effectively guard against the violation of its territory, if the Swiss people will see to it that their military activities are something real and not merely a mirage, is the last message delivered to his countrymen by Colonel Sprecher.

Les deux genres de guerre. Colonel Feyler deals in No. 10 with the situation created in Switzerland owing to the doctrines of the League of Nations.

La cartographie suisse. This is an anonymous contribution, and appears in No. 10. The question of producing new maps of Switzerland has been raised recently ; views as to the scales which should be adopted, V.I. of contours, etc., of a number of persons who are interested in the subject, have been collected and are given.

L'arme de l'air. Lieutenant E. Næf furnishes in this article in No. 11 some particulars relating to the Potez 25, a French machine.

Notre cinquième arme. L'aviation de chasse. Lieutenant E. Næf is also the author of this article in No. 12 ; he describes therein the Swiss A.C.1 machine, and the Dutch machines Fokker D. XIII and the Fokker C.V.D. He further states that recently the question of the Swiss Air Force was raised in the National Council, and an urgent demand made for reforms in this branch of the service. The Swiss War Minister stated in reply that the whole organization of the aviation service in Switzerland was still of a tentative nature, and that it was proposed to carry out further experiments in relation thereto during the current year.

W.A.J.O'M.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1927. TOME II. NOS. 4 TO 6 INCLUSIVE.)

Les opérations de l'Armée belge. The account of the Battle of the Yser is continued, the events of October 23rd/25th, 1914, being dealt with. Short accounts are given of the operations in the neighbourhood of Nieuport, in the Tervaete " loop " of the river, at Dixmude and in the region immediately to the southward of this town. The events of the 23rd are dealt with in No. 4 ; at this time the French 42nd Division was on the extreme left of the Entente line, and had taken over from the Belgian Army the section of the front between the sea and Nieuport. The Germans delivered strong attacks against the Belgian Army on the 23rd ; its 1st Division was obliged to yield ground, but the enemy did not follow up his success at this point. A more serious situation was, however, created on the section of the front held by the Belgian 4th Division ; the enemy succeeded during the morning in seizing the canal bridge at Tervaete and established himself on the left bank of the waterway. Further south, the Germans made a series of attacks on the bridgehead at Dixmude during the night of October 23rd/24th, but were not able to make any progress. It was intended that the Entente troops should launch a combined attack against the enemy forces in the Flanders

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section of the front on the 23rd ; however, the necessary orders were issued at too late an hour for effective action to be taken on them. The situation, as it presented itself to the Belgian High Command on this date, is briefly reviewed in No. 4.

The events of the 24th are sketched in No. 5. Instructions had been issued for a brigade of the French 42nd Division to co-operate with the Belgians on this date, with a view to dislodging the German troops which had obtained a footing on the west bank of the canal in the Tervaete "loop." The Belgian troops were, however, worn out by the fatigues they had undergone, and were further very weak in numbers ; they were not in a condition to undertake offensive operations. Indeed, they could not hold their own against the German attacks, and yielded more ground ; by the evening of the 24th, they had fallen back from the canal along a stretch of front extending to some 14 km. A part of the French 42nd Division had been moved to the southward of Nieuport for the purpose of assisting the Belgians during the day, but it was not able to intervene effectively. Further south, the French troops (IX Corps) continued their offensive in the region of Dixmude ; directing their effort towards Passchendæle–Roulers, they made a slight advance on the 24th. The Germans now delivered strong counter-attacks against the parts of the front held by the French IX Corps and the British 7th Division ; the Entente troops were able to retain their positions.

The situation on the section of the front held by the Belgian Army was, at this time, causing the Belgian High Command considerable anxiety, and a memorandum, the text of which is set out in No. 5, was, in consequence, drawn up reviewing the condition of affairs, and forwarded to the Chief of the French Military Mission. In view of the serious state of affairs on the Belgian front, General d'Urbal, who was in command of the French forces in Belgium, issued orders to his troops at 6.30 p.m. on the 24th, directing them to act in support of the Belgian Army on the following day. The orders issued by the Belgian High Command at 8 p.m. on the same day provided that the Belgian Army should act on the defensive and hold on to its position as long as possible.

Instructions were issued on the 24th to the Engineers of the Belgian 2nd Division, directing them to operate the canal sluices at Nieuport, at the changes of the tides, in such a way as to cause water rushes in the waterway with a view to interfering with the German bridging operations.

The events of the 26th are dealt with in No. 6. The Belgian 5th Division, which was on the right of the Belgian line, near Oud Stuyvenskerke, delivered a counter-attack, on the initiative of its commander, on this date, and succeeded in making a small advance. Further south, the bridgehead at Dixmude was heavily bombarded by the Germans, who again advanced to the attack against the works held by the Belgian and French troops, but were repulsed.

During the 25th, the decision was taken to carry out the inundation of the region eastward of the Nieuport-Dixmude railway. The French had already carried out inundations in the neighbourhood of Dunkirk in September, 1914, and were, at this time, proposing to extend the flooded area eastward of the line Dunkirk-Bergues-Rexpoede. The Belgian High Command, however, opposed the French project for extend-

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ing their inundated area, as the floods would then have reached to the banks of the Yser, and it would, in consequence, have been necessary for the Belgian Army to abandon the line held by it. In view of the representations of the Belgian High Command, the French did not proceed with their scheme. Details concerning the Belgian and French inundation projects are given in No. 6 of the *Bulletin*.

Problème de la sûreté. The 7th article of the series under this title appears in No. 4; Major Barthélémi, of the Belgian General Staff, analyses therein the measures adopted by von Moltke in 1870 for the purpose of ensuring the safety of the German Armies during their pursuit of the French forces retiring on Metz. The article is informative and interesting.

L'effort belge au lac Tanganika pendant la Guerre 1914–1918. The first two parts of an article under this title, by Captain Weber, of the Belgian General Staff, appear in Nos. 5 and 6. The Belgian effort in this theatre was directed towards obtaining and maintaining command over the waters of the Lake; this involved the completion of the railway line, already under construction, to the shores of the Lake; the creation of a naval base to cover the Lake terminus of the railway; and the construction of a flotilla for use on the Lake, and its maintenance in an effective fighting condition. In these circumstances, engineering necessarily played a large and important part in the activities of the Belgians in this region.

La réorganisation militaire et la durée du temps de service en France. This article, which is an anonymous contribution, is contained in No. 5; it deals with the manner in which the French legislature approached the problems relating to the peace and war organizations of the French Army, and in which it also determined the basis of the periods of military service for its component parts. The subject is treated on scientific lines, and the article is not only instructive but also interesting.

Les chars de combat. The first of a series of articles under this title appears in No. 6; Major Liévin, its author, furnishes technical details concerning various types of tanks which have either been introduced into the service or are being experimented with in France, Italy, Great Britain, America and many other countries.

W.A.J.O'M.

COAST ARTILLERY JOURNAL.

A writer in the October number discusses the possibilities of local military schools and the quickest way for the junior officers to acquire knowledge on military matters, both in the general subjects required of all officers, and in special subjects essential only to his branch of the Army. He notes how difficult it is to obtain first-class instructors in every subject in sufficient numbers to be available at all stations, and finally makes out a case for text-books.

Live, up-to-date text-books on every subject, from the pens of the best instructors in the army, instead of lectures and lessons given by lower-grade instructors. Such text-books to be used by all teachers, who will finally supervise the examinations. These will also be prepared by the

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writers of the text-books. The author thinks that if such examinations are carried out on the "hit or miss" principle, questions covering a whole subject can be answered in a quarter-of-an-hour and corrected in less than a minute. His suggestion for an hour's study leaves one rather dazed; it is as follows:—"During the first 30 minutes each student "reads and reviews the lecture. During the next 15 minutes oral dis- "cussion follows under the direction of the instructor. During the "last fifteen minutes the examination test of about 50 questions is "given. . . They can be marked and returned to the student at the "following class."

"They are magic time-savers: thorough to the nth degree: fair "beyond question, and as exact in marking as mathematics." But composition seems to be neglected, which may lead to difficulties in connection with the student's subsequent ability to write orders later on in his career.

An interesting article is given on the question of the possibilities of finding means of subsistence for the armies and civil populations of two (or more) European belligerents in case of another war. For meats, fats, grains, cereals and forage each state is dependent on one or more of its neighbours and also on other continents; Canada, Australia, United States, South America, etc. This being the case in peace-time, might not the supply of such necessities become even more difficult than that of ammunition and warlike stores? Before the War, Italy subsisted on Russian wheat; Germany depended on Russian and Polish poultry and eggs, and partly on Russian barley. Rumania's large wheat yield has been seriously diminished by agrarian legislation; she has actually had to import it herself. Turkey's productive capacity has been brought to a standstill. The economic distress in Hungaria and Bulgaria has caused them to close their exports. Europe, exclusive of Russia, has therefore doubled her wheat importations since 1914.

The shortage includes sugar.

To-day the Argentine, Australia, Canada, India and the United States control the food of the world. If England should not succeed in directing the foodstuffs from Australia, Canada, South Africa and India to her own or her allies' ports, Europe could, in a short time, be starved out as thoroughly as was Germany during the War.

This statement casts an interesting side-light upon the United States' proposal for an overwhelming fleet and the breakdown of the last conference for the limitation of armaments.

In the January, 1928, number a writer describes the military situation of Argentina. He mentions South America's immensity. Of ten republics, three exercise a marked influence on the commercial world of to-day, while one is larger than the United States, and might become the greatest producing state in the world; Argentina, the second, which is two-thirds as large as the United States, is the largest exporter of meats, cereals and hides in the world, while a third produces three-fifths of the world's supply of nitrates. The ten republics produce bountifully almost every essential to civilization.

In Argentina, the people have developed from a mixture of European stocks rather than from a blend of European and native races: in this

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she is different from the others, and consequently, assisted by her wonderful climate, she has to-day an alert, vigorous and progressive population, who respect the relation of law, order and peace to prosperity.

Her territories consist for the most part of vast, well-watered plains. With natural obstacles on nearly all her continental marches, and an ideal internal railway net, Argentina is fairly safe in case of war with any of her neighbours, while over 1,000 miles of Atlantic coast-line would ensure communications overseas. But a maritime invader could reach the vital nerve centre, Buenos Aires, without much trouble at present, though the probability of war with a European country seems remote. Her natural rival is Chili: they both desire the leadership in South American affairs, and have an extensive common land frontier. What looks like a definite boundary settlement, however, appears to have been reached at last.

Every able-bodied male has to register during the first three months of his 19th year: at the age of 20 he is enrolled in the Regular Army (active or inactive): at 30 he passes to the National Guard, and from 40 to 45 he belongs to the Territorial Guard. The service term in peace is one year. The active Regular Army consists at present of about 30,000 volunteers and conscripts, the former being mostly candidates for commissions.

Officers are appointed exclusively from graduates of the government military college, near Buenos Aires, after a four years' course. The training and discipline is excellent, and the pay adequate, with efficiency as the basis of promotion. All schoolboys receive military drill from the age of 12, and at 15 they are trained to shoot. The volunteers must be public school boys, who enlist at the age of 17 and soon become N.C.O.s: those who do not desire a commission become professional N.C.O.s and are allowed to re-enlist up to the age of 50, receiving an annually increasing bonus to encourage them to remain in the service.

The country is divided into five divisional regions, the division at war strength consisting of three infantry regiments, a cavalry regiment, an engineer battalion and a signal battalion. The actual war strength of a division is 16,000.

The government owns and works its own factories for the supply of clothing, boots, tents, aeroplanes, small arms, leather equipment and S.A.A. The arsenal is capable of turning out a million rounds of S.A.A. per diem in war-time. The present equipment and reserve of munitions, however, is not up-to-date.

Though a wealthy nation with great purchasing power, she lacks coal, iron and sulphur, and her inherent weakness lies in the fact that she is not a manufacturing community, but must necessarily be dependent on Europe and the United States.

In the February number another Coast Artillery Corps writer gives an article on the military situation of Brazil.

The largest state in South America, she has a boundary which marches with every other state except Chili and Ecuador, and has had more than the same number of boundary disputes. These are the results of loose wording in the boundary definitions originally laid down by Spain and Portugal for their old colonies.

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Her great strength lies in the vast spaces lying between her land frontiers and her centres of population; the only frontiers open to invasion are those between Brazil and Uruguay, Paraguay and Argentina, and they have been stabilized by treaty. Her sea-coast of some 4,000 miles has a number of important and commodious harbours, which are well connected by rail to the centres of industry.

Brazil has had two successful wars, firstly with Argentina over Uruguay and secondly with Uruguay, but, even so, the feeling of patriotism is rendered to the province, of which there are twenty-two and all independent, rather than to the nation.

Her population consists of whites, Indians, negroes and half-castes: there is no colour line. It is therefore only in some very great crisis that a strong spirit of national unity and sacrifice could be aroused: her only rivalry is with Argentina.

She is essentially an agricultural country and is self-supporting in foodstuffs except wheat and flour, but has corn and rice instead. Her products are principally coffee, sugar, cereals, meat, hides, cotton, rubber and manganese ore, but almost all war requirements must necessarily be imported. Brazil's natural wealth and resources make her financially sound in the long run, but at present her huge national debt makes her present condition uncertain: she could not begin a war without very large foreign loans.

Roads and railway service are poor, except near the large centres.

The country is divided into seven military districts, under a divisional general, but the organization is weak. Every male at the age of 21 is conscripted, the usual service being two years with the colours, seven in first-line reserve; seven in second-line reserve and eight in the militia. The strengths in 1925 were 40,000, with a trained reserve of about 70,000 more: mobilization is estimated to collect half a million, but the law is so unevenly enforced that the actual war army is a very uncertain entity. A division would consist of two infantry brigades, an artillery brigade, a regiment of cavalry, a battalion of engineers and an observation battalion consisting of air, communication and transport troops.

A war against another South American state might be a long affair, as the enemy might have great difficulty in finding and pinning any definite defensive force, owing to the great distances to be traversed and the lack of communications.

An interesting experiment was carried out in Texas when a troop of cavalry, "completely horsed and equipped at all times, ready for such "mounted tactical missions as might be assigned them, during or upon "completion of the journey, was moved by motor trucks a distance of "300 miles over rough country in 36 hours." At the end of the journey, horses and men were reported as being in "good physical shape for any "kind of military duty." Fourteen trucks and a tank were employed: the route passing over country roads and a seventy-five mile stretch of hilly country. 160 miles were covered the first day and 140 the second.

On another occasion a Field Battery was moved 700 miles in a similar manner.

The United States Ordnance Board is said to be completing tests with a self-directing anti-aircraft gun: a microphone in connection with a

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sound locator first swings the gun towards the source of the sound and then fires it. The secret of allowing for "lead" or "lag," however, is well kept, and the actual results of fire are still in the future.

The following guns are also being developed :—

a. 75 mm. pack howitzer—six load parts—9,200 yards range—15 lb. shell—traverse 6°.

b. 105 mm. divisional howitzer—split trail—12,000 yards range—33 lb. shell—traverse 45°.

c. 75 mm. divisional gun—split trail—14,800 yards range—15 lb. shell—traverse 45°.

d. 4·7 in. corps gun—split trail—20,000 yards range—50 lb. shell—traverse 60°.

e. 155 mm. corps howitzer—16,400 yards range—95 lb. shell—traverse 50°.

f. 155 mm. army gun—two loads—26,000 yards range—95 lb. shell—traverse 60°.

g. 8 in. army howitzer—two loads—18,700 yards range—200 lb. shell—traverse 60°.

D.M.F.H.

HEERESTECHNIK.

(*April*, 1927.)—***Barrel-strain caused by Firing.*** An article written by Dr. Schwinning, of the Technical School, Dresden, for the Artillery Proof Committee, in 1918, in which he investigates strains in barrels, simple and compound. The Author, as far back as 1909, worked out the main features of a process for making simple tubes having the properties of layered barrels; but nothing came of it in Germany. It has now attained practical importance abroad under the name of "autofrettage."

Construction and Effect of Aerial Bombs (*continued*). Major Justrow considers the effects of aerial bombs under (1) Impact effect, (2) Splinter effect, (3) Poison effect of gases of detonation, (4) Pressure effect of the same, (*a*) local, (*b*) at a distance.

As regards (1) he finds aerial bombs from 12 kg. to 1,000 kg. far inferior to the common types of shell from 10·5 cm. to 42 cm. He then points out the ineffectiveness of bombs against armour, and gives figures for percentage of hits in American trials against the various types of surrendered ships, deducing therefrom that from a height of 13,000 feet, under battle conditions, aircraft has practically no chance of hitting a ship under way.

Another deduction is that great energy of impact is not in itself an object to be striven for, but only an accompaniment of the high velocity necessary to improve marksmanship. Apart from this only sufficient energy of impact is required to pierce the target and thus allow a delay-action fuze to bring about the bomb's maximum performance. Houses are the chief target requiring penetration. Bombs must not explode on striking the roof, but must be provided with both instantaneous action on hitting pavements and road-surfaces and delay-action for penetrating roofs. Requirements are: against living targets, splinter-effect; against buildings, a large quantity of explosive, in order to obtain

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pressure of detonation gases. Against a railway bridge, the iron members of which to a great extent escape the gas-pressure, destruction is best effected by a bomb combining powerful splinter-effect and gas-pressure. The size of bombs depends on the nature of target, but the size should not be increased unduly at the expense of the number of bombs carried. The container must be strong in the head and in construction generally, so as to stand the impact, but, apart from this, there is no necessity for great strength as is the case with gun shells. The larger a bomb, the greater in proportion is the charge, varying thus from 40 to 70 per cent. of the total weight. Bombs for use against troops and dug-outs should correspond in effect to the 7·7 cm. shell.

(*To be continued.*)

Russian Views of Constructional Measures for the Protection of the Inhabitants of Towns against Air Attacks (continued). The same view is adopted by another writer, Koshewnikow, who, in a treatise on this subject, holds it as quite incredible that civilian building should, in naïve and innocent lack of understanding, persist in its standpoint that it is not concerned with war. He thinks that the only explanation for this failure lies in the absence of a sufficiently strong impulse towards a correct understanding, such as would have been given by the air-bombardment of Berlin, projected and prepared by the Entente Powers for 1919. For the planning of towns in future and for the improvement as much as possible of existing towns, Koshewnikow lays down many principles, based upon an axiom that the degree of destruction by air-bombardment will be directly proportional to the degree of crowding together of the buildings and to their height. They are :—

(1) The crowding together of buildings cannot be permitted ; towns must be decentralized.
(2) Houses may be extended down, but never up.
(3) There must be as many as possible trees, gardens and parks.
(4) Underground railways (as projected in Moscow) and underground cinemas, as gas-shelters, are recommended.
(5) The proportion of the area of streets and open places to the area covered by buildings should be increased to 1 : 1.
(6) All streets to be made as broad as possible.
(7) Main streets to be laid out S.W.–N.E. so as to be swept by the prevailing wind.
(8) Houses to be built at least the distance of their own height from the street and from each other.
(9) In crowded towns no old or burnt-out houses to be replaced.
(10) Artificial pieces of water and fountains are recommended at the ends of main streets.
(11) Blind alleys and places where gas can collect to be opened up.
(12) Government offices not to be in large buildings in the centre of the town, but in groups of smaller buildings in spacious and inconspicuous surroundings.
(13) Regularity of line to be avoided in planning, so as to make identification from the air more difficult.

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As regards the houses themselves:—

(1) No building to have more than three storeys above ground.
(2) The rules for foundations, walls and floors, to be as in earthquake areas.
(3) Cellars, or where they do not exist, stairways are to be fitted up as gas-shelters.
(4) The subterranean portion of new buildings to be covered with reinforced concrete.
(5) Glass windows in gas-shelters and stairways to be replaced by triplex in iron frames.

If many of Koshewnikow's proposals sound at first too utopian, it must still be conceded that, owing to the rapid advance of science and technics, what seems fantastic to-day may become reality to-morrow. It is equally certain that, in the present rising Russia of the Soviet Union with its wide and thinly populated spaces, where the State is sole owner, many a measure is capable of being carried out which simply cannot be taken into consideration by West European nations. An interesting case in point is the new capital of Siberia at what used to be called Novo-Nikolaievsk, which has been almost stamped out of the ground.

The Author of yet another treatise on this subject, Truchatschow, takes a more definite standpoint. He says that, as it takes 12 feet of reinforced concrete or 60 feet of earth to afford protection against a 2-ton bomb, no state can face such provision. The only rational method for large towns, say, Moscow with 1½ million inhabitants, is to build a deep underground railway network, capable of evacuating all the inhabitants of a sector of the town in from 35 to 40 minutes, and large enough to afford accommodation for the whole of the inhabitants.

As this system is obviously inapplicable to small towns the following measures are recommended:—

(1) The cellars of the most massive buildings to be registered with their capacities, and preparations made for strengthening them.
(2) All subterranean passages to be opened up and put in order.
(3) Suitable places to be chosen for galleries to be mined and the necessary material prepared.
(4) All telephone, electric light and power cables to be put in underground.
(5) Businesses which it is necessary to carry on above ground to have their premises strengthened and camouflaged.

As regards defence against gas-bombardment from the air Truchatschow distinguishes:—

(*a*) The prevention of gas from penetrating into occupied places.
(*b*) The localization of the effect of gas by making its spreading more difficult.
(*c*) The removal of gas.

For all these cases, provision should be made of fresh air to the whole town from gas-free districts outside the town, and also for sucking out infected air.

As the tubes necessary to provide the fresh air may need to be as

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large as two metres in diameter, the underground railway system must be used for this purpose. Systems of smaller tubes for distributing fresh air are to be laid down in peace and might be made available for the post office pneumatic parcel service.

(*To be concluded.*)

Construction and Effect of Aerial Bombs (continued). For the effective destruction of factories, railway stations, large bridges, etc., the bomb with great splinter-effect is not suitable. Here it is better to use the bomb with a large quantity of explosive. Ideas as to the necessary size of these mine-bombs vary considerably, inasmuch as no simple method of comparing effects has as yet been laid down. The largest bomb in the War was the German one-ton bomb containing two-thirds of a ton of explosive, but since the War the United States have produced a bomb intended principally for use against battleships and containing nearly one ton of explosive.

In mine-bombs, both splinter-effect and poison-effect are entirely subordinate to pressure-effect. The most difficult task remains, viz., the determination of the destructive radius of the air-pressure wave of a detonating bomb. TNT, Picric Acid, and other explosives, which were used in the War, had detonation-velocities of over 6,000 metres a second.

It stands to reason that the more rapidly the explosive detonates, the more gas is formed in unit time and the greater is the blow. We must, therefore, be prepared for the development of explosives for mine-bombs along the line of increase of detonation-velocity, as well as increase of volume of gas and increase of heat. This does not apply to splinter-bombs nor to shells, where such an increase would mean breaking up into smaller fragments than required, and an increase of sensitiveness which would make the explosive unsafe for shells. The detonation-velocity of, say, 6,000 metres a second is not transferred as such to steel case or to surrounding air, but the gases formed by the explosion and the amount of heat set free produce an enormous pressure which is transferred to air and earth. It is not possible to measure this enormous pressure at the place of its origin, as no instrument could stand it, but it has to be deduced. Hopkinson, Landon and Quinney, worked out a pressure of 120 tons to the square inch, but the Author, basing his opinion on the tension required to tear in two a steel rod, considers this figure far too low. Using Waals-Abel's formula, he works out for TNT 540 tons to the square inch even when its density is as low as 1.

A chart of seismographic records of explosions shows how the ground-waves with their small amplitude arrive first at the recording station, followed by the air-waves with their large amplitude heavily damped. An attempt is then made to check, by means of pressure measurements of various explosives, the different formulæ propounded, viz.:—

$$\text{pressure} \propto \frac{1}{\text{distance}}; \quad \text{pressure} \propto \frac{1}{\text{distance}^2}; \quad \text{pressure} \propto \frac{1}{\text{distance}^3}$$

(Berthelot's formula) (Rüdelberg's formula)

and the results are summed up as follows:—The initial shock of an

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explosion is approximately proportional to the size of the charge; the pressure at the seat of explosion is extraordinarily high; at first it falls off very quickly, being inversely proportional to the square of the distance; from 4 metres' distance to 500 metres' distance, the pressure is inversely proportional to the distance.

Practically, this means that at 500 metres from an explosion of one ton the pressure is ·04 kg. per square cm., or sufficient only to break windows, while at 50 metres from the same explosion the pressure is 3 kg. per square cm., or sufficient to knock down a thin brick wall of large surface.

The Author deduces that a small concrete shelter sunk in the ground with walls half-metre thick is proof against the air and earth pressure-effects of the largest known bomb, provided that the bomb bursts at a distance from it greater than the radius of the crater.

(*To be concluded.*)

Russian Views of Constructional Measures for the Protection of the Inhabitants of Towns against Air Attacks (concluded). If it is not possible, for financial reasons, to make a central ventilation system for the whole town, there must be provided smaller systems for single buildings, with the twofold object of producing the requisite excess of pressure in the living-rooms and of drawing the infected air away from the house. It is in this second object that Truchatschow goes farther in his demands than Pavlov. The air to be forced into the living-rooms, except when it is taken from a great height, must be passed through a gas-filter. Together with these measures, Truchatschow considers necessary the issue by Government of regulations for the planning of towns in such a way as to provide ventilation and to remove from town-design everything likely to cause gas to accumulate.

As the first real impulse to creative activity of Russian town-builders and architects, and for the awakening of constructive thought in this direction, he proposes a competition. It is interesting to note how quickly this idea was taken up. In the programme of the Defence Section of the Aviachim appear the following tasks:—

No. 13. "The working out of a plan for the building of towns and large Government establishments in accordance with the demands of air-chemical defence."

No. 14. "The working out of practical measures for the collective gas-protection of dwelling-houses and public buildings in association with the organs of the People's Commissariat for Internal Affairs."

From the foregoing it becomes clear what importance is attached in Russia to the problem of the protection of important towns and centres against air-attacks by gas and explosive bombs, and what possibilities are being considered in solving it.

And what of Germany? The Author laments that no German "Aviachim" for stirring up the authorities and the people has yet been formed and that it is only in *Russia* that people think of what steps might be taken in Germany to protect the inhabitants of towns against the new air and gas weapon which continues to develop increasingly.

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(*June*, 1927).—*The Gauge-proving Shops at Spandau Arsenal and their Importance to the Army* (concluded). In proving gauges the principal points to be attended to are temperature, pressure of application and contact-errors. As regards temperature, the standard metre is the distance, at the temperature of melting ice, between two lines on an iridio-platinum rod kept in Paris. The standard metres of other nations, which have agreed to the metrical convention, are of the same material and form. Their errors have all been determined. The standard-metre in Germany, for example, is ·0017 mm. short.

As regards measuring-pressure, in the case of bullets and other objects of small cross-section, owing to flattening the pressure of application should be zero. Older types of measuring machines allow of pressure from 3 up to as much as 7 kg., but Zeiss, the optical instrument-makers, who lead in these matters, work with their latest machines to a pressure of 150 grammes (5·3 oz.).

As regards contact-errors, the making of a perfect surface, either plane or cylinder, is impossible. By most accurate measurement with the appropriate instruments there will always be found slight deviations which cause surfaces, which should fit together, to fail to touch at every point. This distance apart is called the contact-error, and varies according to the degree of finish and to the size of the surfaces in contact. With equal degrees of finish, the contact-error is largest when tested by surface-contact, less with line-contact and smallest with point-contact. If a cylindrical bore is measured by these three different methods, three different results will be arrived at, and up to the present no correlation has been possible.

The article concludes with some general remarks on the proving of gauges, but says that, as far as gauges for the Army are concerned, they differ so widely that no general instructions for proving them can be given. Each case must be separately considered, before deciding how the proving is to be carried out in the most appropriate manner and most correctly.

Automobile Development in the United States and in Germany. The occasion of the annual publication by "Automobile Industries" (February number) of the latest statistics about automobile manufacture in all countries is utilized by Dr. Stadie for making deductions as regards types of cars and prices, engine-details, number and size of cylinders, revolutions, braking and tyring, and generally as to the trend of manufacture. An increase of 3·7% in the number of automobiles produced in the U.S.A. and Canada during the year under review, as compared with a 20% increase the year before, points to the saturation of the American market, and indicates that the maximum production of the U.S. automobile industry has been reached, if not passed. We must be doubly armed to resist early American efforts to capture European markets.

The Construction and Effect of Aerial Bombs (concluded). Major Justrow sums up:—Increase in size of bombs is tempting when one observes their powerful local effect. Further, since with increased efficiency of A.A. defence the height at which the bomb is released must increase, and therefore its chance of hitting diminish, a large distance-

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effect of the bomb which does not get a direct hit, is desirable. This latter argument, it is true, applies to us (Germany) and not to our enemies, who will have no successful A.A. defence to reckon with. Against the larger bomb can be urged that less hits per trip can be obtained, and although the local effect is directly proportional to the size of the charge, the distance-effect falls off very much. The author thinks that the 1-ton bomb brought out before the end of the War was already too large, and that the smaller destruction effect of a 300-kg. bomb is more than compensated for by there being three chances of hitting instead of one. This question has got to be decided by the various nations, but it seems to him probable that the bomb of 1-ton and over will be reserved for special tasks, *e.g.*, the destroying of a pier of the Rhine-bridge by a direct hit. He considers that also in the choice of medium and small bombs limitation is the key-word—a 300-kg. bomb for specially important and extensive targets, *e.g.*, factories, a 50-kg. bomb for fortified towns, dug-outs, etc., a 12-kg. splinter-bomb, and perhaps a quite small hand-grenade for use against aircraft, might fulfil all requirements.

What of the targets? The most paying are ammunition-dumps, either at home or in the field, explosive-factories and shell-filling establishments. A well-aimed small bomb (50 kg.) may wreck a whole ammunition-depot, a whole explosive-factory. Such places on account of expense cannot be protected against bombs. They can only be camouflaged and built so as to localize damage and explosions. Other important targets are large factories, especially their power-stations, iron railway-bridges, large railway-stations, fortified towns, shelters, etc. For all of these sufficient protection from above is hardly possible on account of the enormous expense. The destruction of a single building will not as a rule put a whole factory out of action, unless that one building is the power-station. The latter must, therefore, be camouflaged, and it is even worth consideration whether it should be given reinforced concrete protection.

Generally, it may be said that the ever-growing fear of air attack should drive only the human being underground. It will only be in the rarest instances that arrangements can be made for works to be carried on under earth protection. How far powerful elastic nets over important buildings afford protection against bombs has not yet been proved by trial. As regards river-crossings, the author says that an armoured roof over a bridge would come more expensive than an alternative bridge (which may be doubted), and that in any case it cannot be made absolutely safe.

As regards the protection of people, it is not possible to guard them against direct hits of large bombs. Of these they must take their chance. Half-a-metre of reinforced concrete will probably suffice against direct hits of bombs up to 50 kg. Shelters of this nature, as numerous as possible, small, well-distributed and easily accessible, must be provided where, owing to the importance of the establishment, repeated attacks are to be expected, and where crowding together cannot be avoided, *e.g.*, in important factories, gas and electricity-works, railway-stations, etc. The existing subways of the latter can be comparatively easily made into shelters.

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For the remainder of the population cellars will have to suffice, but in order to meet the case of the upper storeys falling and blocking the cellar-entrances, fresh cellar-exits will have to be provided leading direct into the open air. One should never lose sight of the fact that the best and cheapest protection for men and buildings against the air lies in the active and passive defence of our aircraft and guns.

Lendvay's Protractor. The firm of G. Thiemann, Berlin W.50, Marburgerstrasse 16, has put on the market a combination of dividers and protractor, designed by Major von Lendvay, of the Hungarian Army, and intended for the use of officers reading maps. The dividers can be used up to a 6-in. span, and the whole can be carried easily in the waistcoat pocket. One compass leg ends at the top in a circular plate, half of which is graduated in degrees and the other half, for artillery purposes, in 320ths of four right angles. A separate plate with four pairs of points at fixed distances apart (·5, ·8, 1 and 1·3 cm.) can be fixed by means of a screw at the centre of the protractor, over the edges of which any required pair of points can be pushed forward. Distances and scales are marked thus—between one pair of points " ·8 " means that the points of this pair are ·8 cm. apart. On the right " 100 " and on the left " 12·5 " mean that this distance represents 100 metres at a scale of 1 : 12,500. And so on for other scales and for other pairs.

One compass leg is graduated in millimetres, the other is flattened and serves as a stencil for marking on maps column of route, march-lengths of brigade, battalion, etc., and is provided with scales of metres and of paces at 1 : 75,000.

The French Regulations for the Training and Employment of Engineers, 1926. It is instructive to see how these Regulations strike the German reviewer.

The difficulty about the training of the French Engineers, which include the Signal Service and Railway Troops, is their manysidedness. Generally, it is sought to surmount this difficulty by posting to the Engineers recruits who have had appropriate previous training in civil life, and also by specializing, *i.e.*, by forming Engineers of various main types and not training all Engineers in every branch.

The wider this specialization is, the greater becomes the total number of Engineers necessary. As a counter-measure, it is attempted, in addition to a man's special training in his own branch, to give him enough training for him to be able to take his place as an assistant in other branches. Comparing this with Germany, the author complains that owing to the limitation of the Engineer arm (14 Engineer Coys. to 10 divisions), forced by the Treaty of Versailles and the subsequent decisions of the Inter-allied Military Control Commission, specialization could only be undertaken to a very limited extent. It is true that 14 Signal Coys. were also permitted, which could be diverted as Engineers, but railway troops had to be entirely renounced.

The Germans were obliged to hold fast to the Universal Engineer, capable of undertaking every kind of technical work, and even to develop him so as to keep abreast of the advance in civil technics. In the face of the Engineer's plethora of tasks, the German long-service (12 years), so far from being a set-off, acts disadvantageously in that it keeps away

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the very person needed—the tradesman. A noticeable example of this is in the Bridging branch, in which the watermen, even in 12 years' service, do not attain the proficiency of the so-to-speak born waterman, while the French, with their short service, have at their disposal strong well-trained and intelligent recruits taken from a numerous and capable class of watermen, trained on their many canals and on the swift rivers of the Western Alps.

The short period of service in the French Army makes specialization in the Engineers the best system, and they are still able to give their specialists sufficient training for them to be of use in other branches. " If one recognizes as correct the dictum of an Englishman that ' that nation has the best chance of winning the next war which can change with the least friction its peace economy for carrying on war, and bring every man to that spot where, in accordance with his peace activity, he can employ his powers in the most effective manner,' then the French have, with their specialization in Engineer-training and their systematic distribution of tradesmen-recruits, approached very closely to this ideal."

After this piece of very high praise the reviewer takes exception to the inclusion in Part I of a special drill for the Engineers—with a special weapon, the carbine—holding it better to do as the Germans do, *viz.*, equip, train and drill the Engineers as infantry. This may safely be conceded, not only because of such help as Engineers may in exceptional cases afford by acting as infantry, but chiefly because it ensures that the Engineer will understand the principles of infantry action.

An introduction to the Regulations formulates the principles which guided the commission of four senior officers who collaborated in writing the book. While recognizing that national feelings and ideas must govern in these matters, the reviewer, instead of the French idea of convincing the subordinate of the necessity and appropriateness of his orders, so as to obtain from him the utmost obedience, prefers the German way of basing " even now " the obedience of the subordinate more upon his sense of duty and will than on any conviction.

He finds it also " characteristic " that the commissions charged with writing Engineer-manuals were presided over by infantry-officers (divisional commanders) and included each an artillery officer. This composition, however, he considers justified on the grounds that the Engineer arm exists for the purpose of serving the fighting arms, of which infantry and artillery are the chief.

In a report to the Minister of War, mention is made of the changes in Engineer establishments since the War, *viz.*, considerable increases in Telegraph troops and in Bridging troops, the re-inclusion in the Engineers of Light Railway troops and the raising of special electro-mechanical, heavy bridging and water transport units. The reviewer states that these changes coincide with what the Germans had also worked out from war-experience as necessary in their own army. He points out that the omission of Gas and Flame-projector units, in accordance with the Washington Agreement, by no means implies an unconditional renunciation of the weapons concerned, and thinks it would be better to reckon on these Engineer branches being also represented in the French Army.

The remainder of the instalment consists of an interesting résumé of

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the contents of Part I, but without any comments or comparisons with the German Army.—(*To be continued.*)

Petroleum and the Air Force. " L'Aérophile " is quoted to the effect that the great difficulty of providing the French squadrons with petrol during the War is no secret. The story is still told in certain circles of a ship which arrived from India with a cargo of castor-oil, the opportune arrival of which alone saved a cessation of activity in the air. Thus the French Air Force was for some time at the mercy of a German torpedo. This lesson of the past is not forgotten, and the Cabinet will certainly bear it in mind as soon as they are occupied with the question of the Petroleum Monopoly. The questions to be asked of the War Ministry are :—Is our Air Force completely dependent upon foreign countries for petrol? Have we sufficient provision for war? Can we in war make certain of replenishment?

(*July*, 1927).—*The International Motor-lorry Exhibition at Cologne, 20th–31st May*, 1927. This was the first international exhibition of automobiles in Germany for fifteen years; in spite of which very few foreign exhibits were sent. Dr. Stadie attributes this to the facts that in this particular branch—as opposed to cars—Germany has already recovered her pre-war lead. He makes certain deductions based upon the statistics of the Exhibition :

(1) Germany evidently strongly inclines to the heavier type, over 80% of the exhibits being of over 2 tons, whereas the latest returns from the U.S.A. show that 96% of all motor-lorries are tenders under 2 tons.

(2) The best method of coupling, decided as regards cars with the dry multiple plate, is not yet decided in the case of lorries, where cone-clutches are still plentiful.

(3) The lorries tend also to go over to six cylinders.

(4) The question of valves is also not yet decided with the lorries, of which 58% still have the hanging valve.

(5) The most popular lorry is the 3–3½ tonner, as evidenced by the greatest number of types shown (11), and by the fact that only three of the leading firms, Daimler, Hansa-Lloyd and Vomag failed to put in one of this type.

The Trying-out of Substitutes for Petrol in France. A list is given of the cars which took part in the Automobile Club de France race of 1,700 miles, which occupied 13 days of March and April last year. Half of the total starters were lorries, viz. : 3 Panhards, 2 Renaults, 3 Berliets, 1 Le Dion, 1 Peugeot and 2 others. These were exclusively gas-driven, burning wood, wood-coal or Carbonite (a compressed wood-coal). The remainder were : 1 Ford and 2 Citroën cars, using Acetylene ; 2 Peugeot cars using Pétol (? Ketol, a product of cellulose) ; 1 car using Heavy Oil (" Held " engine) ; 1 car on compressed Methane ; 1 car on pure alcohol ; 1 Government car on Methyl Alcohol ; 2 Army cars using Benzol-spirit mixture.

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Lectures and demonstrations were given at various places en route. Communication of the results of the trial was promised after full investigation.

Safety Arrangements in the Storing of Ammunition, by L. Stegmann. Germany, having been obliged under the Peace Treaty to destroy almost all her remaining ammunition supply, has at any rate been spared the large accidental explosions which have taken place in other countries. Lessons are, however, to be learnt from these accidents, and their teaching should be compared with what we formerly considered necessary for safety in these matters. The largest disaster of this nature occurred at Lake Denmark, U.S.A., on 10th July, 1926, and a full report of it is given in " Army Ordnance " for Sept.–Oct. of that year.

Fire was caused by lightning-stroke at 5.15 p.m. in temporary store-house No. 8. Black smoke poured out at once, and at 5.20 the store blew up, followed five minutes later by temporary store-house No. 9, which stood next to it in the same line of buildings, and 36–37 metres away. Many other explosions followed, some larger, some smaller, the most severe being that of shell-house No. 22, situated 580 m. from No. 8, which occurred at 5.45 p.m.

The report of the Court of Enquiry was divided into three parts, *viz.*: 1. Finding of Facts. 2. Opinions. 3. Recommendations.

The Court found that the buildings were provided with lightning-conductors and that they were in good order. They added, however, a rider that all metallic parts of buildings and also all metallic contents of buildings, should be earthed, so apparently these important safeguards had been omitted. The necessity for this precaution lies in the fact that these masses of metal serve to form induction currents, the effect of which has often been to cause greater damage than the lightning-stroke itself.

The explosives stored in No. 8 did not go up immediately the lightning struck, but five minutes later. This shows that the lightning first set fire to some inflammable stuff, and that two different kinds of explosive were stored in the same building. The Court of Enquiry's first recommendation was that this practice be avoided in future. The German Regulations for Practice Ammunition forbade this originally in 1906, but have since been modified to the extent of laying down what particular kinds of ammunition may be stored together.

An appendix to the report contains observations of the effect of the explosions on the buildings of Picatinny Arsenal, in the neighbourhood of Lake Denmark, from which it appears :—

(1) That, after windows and doors, roofs suffer most.

(2) The better the roof holds together, the more damage is done to the walls.

(3) Walls and partitions in order of resistance starting with the weakest : corrugated-iron sheeting, wooden panelling, brick walls, XPM, stone walls, reinforced concrete.

(4) Store-houses that were nearly full offered greater resistance than empty ones.

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Based upon the foregoing and upon his own experience, the writer then lays down his own conclusions. He considers it of the greatest importance to choose materials for walls and roofs, so as to exclude as much as possible the formation of wall-splinters and of air-pressure waves. A charge of powder burning in the open air develops only quite slight air-pressure; with modern powder there is even none at all. The more, however, a charge of powder is enclosed, *i.e.*, the smaller the admittance of air to the space in which it is burning, the greater the development of energy. In Germany, peace powder-houses were built accordingly. The external walls consisted of a rammed mixture of chalk and sand, and were only just strong enough to carry the roof, windows and doors. Inside they were plastered with cement mortar, outside with a good hydraulic mortar, and also oil-painted. The roofs were made of light woodwork, and carried over their planking powdered pumice-stone and an outer layer of mill-board. If a building like that was blown up, it would dissolve into a cloud of dust—forming no splinters and allowing no appreciable air-pressure to develop. Unfortunately no such instance is known, but two of these powder-stores had to be removed to make way for other buildings, and yielded to dismantling very easily. Where the danger is less, as in shell-stores, the whole building has been made of reinforced concrete, and in some cases the two methods have been combined, *i.e.*, a reinforced concrete framework has been built with partition walls and roof, as for a powder-house.

The more dangerous the stores the smaller should be the store-house. The 1926 Regulations lay down that one or two walls are to be built lighter than the others, so that the air-pressure waves may be sent off in the least dangerous direction—presumably, when such a direction exists! Ventilation is of great importance to prevent the collection of inflammable gases through possible decomposition, but also in order to keep down the temperature inside the buildings and to avoid "sweating" on the walls. Ventilators should be provided just above ground-level, and also under the eaves.

At Lake Denmark, buildings sunk in the ground proved their value against air-pressure waves, but they introduced difficulties of drainage, ventilation and the loading and unloading of stores. Also at Lake Denmark the protection afforded by natural rises in the ground was effective. Where such do not exist, earth-parapets can be built up, but these are such a hindrance to traffic that it is better to space the stores well apart (50 metres) with a considerable distance (500 metres) between the depot and administrative offices, quarters, shops and power-station. Such intervals should be planted with trees, conifers for choice, since deciduous trees afford little protection in winter, and their leaves when dry are a danger as regards the outbreak and passing on of fire. The subject has a dual aspect, the guarding against explosion and the minimizing of its effects when it occurs. The latter province is the Engineer's own; in the former he has an all-important part, but the rest is left perforce to the "care and conscientiousness of the ammunition personnel."

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MILITÄRWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

JULY—AUGUST, 1927—(*continued.*)

Technical Weapons and Services (continued). Lieutenant-Colonel Paschek, having given us in the last number a list of the tasks devolving upon Engineers, now gives us his ideas of how they should be organized.

A. In the Division.

The Engineers of a Division consist of a Pioneer battalion (H.Q. section, 3 ordinary coys., 1 specialist coy., 1 park section, 1 stores section, 2 light Pioneer columns with 2 rapid bridges). If the Division is acting independently, a Construction battalion is added (H.Q., 3 to 4 Construction coys., and 1 light Construction column). The ordinary coys. of the Pioneer battalion are organized for quite independent use, and also half-coys. and sections can work independently. Divisional Pioneers, as compared with Brigade Pioneers, carry heavier tools, more explosives and tank-mines and more technical equipment for close-quarter fighting, obstacles and temporary bridges, also 1 or 2 m.g.'s for ground and air-defence, rams, field forges and, where possible, a power plant. The travelling equipment is limited by the fact that the vehicles have to conform to the fighting transport, and must always be kept down in numbers.

The Specialist coy. would, as a rule, contain a chemical section, a search-light section, a camouflage section, and a fourth section corresponding to the special needs of the field of operations, *e.g.*, a stone-borer section. In the first section are troops with gas-projectors and medium flame-projectors, in the second section are worked light and medium incandescent and arc-lights (25 to 60 cm.). The camouflage section is equipped for works on a fairly large scale. Stone-borer sections are equipped for working electrically or pneumatically. The transport is on a larger scale than that of the ordinary coy., so that possibly some of the equipment will have to be included in the Pioneer column.

The Bridging columns are for bridges for opposed crossings. The rapid foot-bridge equipment is to take infantry, cavalry and cyclist-detachments, mountain-batteries and quite light armoured-cars. It is in certain cases handed over to the fighting troops and erected by their Pioneers. The Bridging column also carries materials for all types of wooden bridges and of divisional bridges for the forward area, especially for the neighbourhood of the enemy. Loads are to include all weights of vehicles within the independent Division or within the Corps: 4″ guns, 6″ howitzers, 8·4″ mortars, laden 3-ton lorries (many countries demand 5-ton) with trailers, and at least light tanks. M.T. is desirable, with the possibility of transference to H.T. A column to carry up to 140 metres' length of bridge would require 10 ordinary and 30 moderately heavy wagons. In case of need the whole can be packed on M.T.

The Pioneer column carries in 20 to 30 medium wagons, or a less number of lorries:—(*a*) In any case, a portion of the special equipment of the Pioneer battalion, including a fairly large power work-shop

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(*b*) Supplementary stores, tools, explosives, camouflage, and consumables for all units of the Division, and reserves of the same. Two important points are that the column must carry equipment already prepared for temporary bridges and that it cannot dispense with a certain number of technical personnel, say, one section for the three columns.

The Construction coy. carries almost exclusively earthwork and woodwork tools, which simplifies also the Construction column of the battalion. This column, which carries also a reserve of entrenching tools and construction material for the fighting troops, is in any case to be estimated as 40 medium H.T. vehicles strong.

B. In the Corps.

The principal Engineer unit in the Corps is the Pioneer Regiment.

Other units are: An independent battalion of Pontoneers for opposed or rapid crossings on a larger scale; at least one regiment of Construction troops; and—as far as they are organized separately—Road construction battalions and Corps tool columns, similar to those of an independent Division. Each Division must keep one battalion of G.D. Pioneers permanently allotted to it. Even the French, who are so much given to centralizing, do not depart from this.

C. In the Mounted Division.

As the fighting methods of the Mounted or Light Division do not differ widely from those of the Infantry Division, the duties, composition and equipment of their Engineers will be the same, but more M.T. is necessary, and for the whole of the Tool columns it is essential.

D. Army Pioneers.

Army Headquarters and General Headquarters need Engineer units:—

(*a*) As reserves to allot to army units or to armies.

(*b*) For the very large constructive services in their own areas. This applies also to the case of L. of C. areas, where formed, and in any case for the administration of back areas. The rule is that, the farther from the front, the less is it necessary for such organizations to be military and the more they pass into the administration of the state and of private undertakings. This is most in evidence in the home country.

(*c*) For technical assistance to all portions of the Field Army. Accordingly, we find among army pioneers the same pioneer-formations as among the components of the Army, together with special ones available for allotment elsewhere or used by the Army itself. Reserves of personnel are kept here in great numbers and divided up into many branches. They make it possible for the number of pioneer troops, commands and establishments to be increased, or for new ones to be created, which experience shows to be often necessary. Similar to the pioneers of the armies, are retained at G.H.Q. about one Pioneer regiment and at least one Construction regiment *per* army, also Divisional bridging columns in varying numbers. Regiments and battalions for road construction and in every case for railway construction are increasing in number.

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The following are specialists : Pontoneer bns., chemical bns., technical close-quarter fighting and miner coys., search-light coys., camouflage coys., and finally motor-boat coys. and river-running coys. The composition of their chemical warfare troops is kept by the nations particularly secret. Search-light coys. are medium and heavy (60 cm. and 150 cm.). The camouflage coys. are for camouflage tasks on a large scale. The close-quarter fighting and mining coys. are principally intended for position-warfare. There is a disinclination to provide fortress-engineers proper, since modern permanent fortification is chiefly a matter of scattered and camouflaged " Fortified Zones," and the fighting for such does not differ so much as formerly from the attack and defence of field-positions fortified for prolonged occupation. For the still remaining permanent barrier fortifications we need at most the provision of special material, but not of special personnel.

Motor-boat coys are provided by G.H.Q. for large and difficult undertakings of crossings and to assist in bridge-building. They can also be used for fighting purposes on rivers and canals, and for transport. The equipment is either confined to definite large waters or is loaded on wagons or lorries. Where there are no proper river-navigation troops their duties devolve upon the motor-boat, bridging and pioneer units.

River-mining coys. for attack and for blockade have equipment columns with mines and mining accessories.

Special services are also provided, with varying organizations, by electrical bns., field railway coys., telferage coys., railway-construction coys. and heavy-bridge construction coys.

Electrical battalions work either by connecting up to local power-stations or by means of their own plant. Their composition is characteristic—two to three similar coys., each with a small amount of transport, and a very large battalion column. The coy. consists of H.Q. section, one section tradesmen, and 3 to 4 sections of auxiliary labour. The column contains a great variety of equipment for work-shops, boring, lighting, pumping, electrified obstacles, etc. Lorries are used to carry the dynamos, transformers, etc. Field-line and Telferage coys. have their equipment organized according to practical units for use (*e.g.*, the Austrian light railway section is for 30 km. of line, and 3 trains carrying 400 tons daily).

The Telferage coys. are for providing light lines in forward areas, heavier lines in back areas generally being done by civil firms. Equipment is generally held ready in wagon-loads and loaded on the military railway or on army lorry columns only when required. That of broad-gauge construction coys. remains, whenever possible, in tool units until it is used, and the same with the equipment of the Heavy Bridging coys. for army iron bridges. These bridges, after rapid foot-bridges and divisional bridges, form the third kind of bridge of the field army. The iron road-bridge carries all loads up to 17" howitzers and heavy tanks; the iron railway bridge carries all broad-gauge traffic. Both the Austrian types, Herbert and Roth Wagner, have made good.

Technical supplies *en masse* are provided by the Pioneer branches of the Army Field Stores. The latter will be arranged for at or, at least,

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close to the railway, and will be as far as possible subdivided according to technical branches.

Material can partly be parked in separate wagon-loads, or it can be sent forward to smaller depots of army-formations. In exceptional cases the formation of special depots for stores required for definite tasks is justified.

The tendency is to do away with purely Pioneer parks, since generally stores have to be replaced, building-materials procured in large quantities and prepared for use, so that Engineer work is inseparable from storing. Such work is done by the Army Artificer Coys., assisted by Labour Coys.

Peace-Organization.

Peculiar to the Pioneers is a peace-organization into regiments (English brigades) and independent battalions, which makes training as simple as possible. Over these are group-commanders and technical inspectors, and above all an Inspectorate of Pioneers. Besides the regimental units, there are military technical schools, research and experimental establishments, instructional troops and camps of exercise, and establishments for production and assembly.

For a transition as frictionless as possible to the much more numerous and more extensive organizations of the Field Army, a very wide-embracing mobilization plan is necessary. The War Ministry must—in accordance with the laws for the general organization of the country and the auxiliary services—not only seize upon the unfit and oldest categories, perhaps for the greater part for technical services, but must also comprehend all national and private measures. The troops are altogether overburdened with reserves of personnel and material, even when parks and stores are concentrated in large depots at head-quarters.

Large nations, the armies of which are formed into groups of armies, necessarily build upon the Pioneer Brigade, which is the army engineer unit, but can also be used independently. Such a body might, in peace, include: Brigade Staff, 3 to 4 bns., construction regiments, a reserve for the special coys. of the Pioneer field bns., a reserve and a depot for park and store services with bridging and pioneer columns. In peace, each bn. of this brigade would contain staff, 4 coys., 2 reserve-detachments and 1 stores-depot for the following portions of the field Pioneer bn., 3 G.D. coys, at least 3 coys. of Infantry Pioneers, at least 6 Construction coys. and the pioneer train.

For a field army with independent divisions the independent Pioneer bn. on the same principle takes the place of the Pioneer brigade. Cavalry pioneer detachments of the mounted division should have their own peace-cadres.

General.

We have seen that the engineers of the countries which are free to develop their armies are utilizing, up to the present, all technical innovations or, at any rate, are still trying these out. The fighting arms and labour tend to become more separate. In training and in methods of working, as also with equipment, which is in many countries in a backward state, the greatest simplicity and standardization are being sought. Machinery must help.

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In the next few years there are no indications as yet of revolutionizing technical innovations likely to influence Pioneer organization fundamentally. To us "conquered" (the Austrians) the most effective technical weapons are forbidden. We must the more endeavour to become masters of these weapons in imagination, since the day must come when our war-technics will once more be free to unfold.

Permanent Fortification (continued), by Colonel Schneck. In this number the consideration of the *rôle* played by permanent fortification in the Great War is extended to :—

(2) *Belgium.* The Belgian fortresses, dating from Brialmont, could not long withstand modern heavy artillery. They were thus unable to prevent the violation of Belgian neutrality, but by delaying the German advance (Liége) or by keeping German troops away from it (Namur and Antwerp) they achieved their purpose.

(3) *France.* Verdun—Toul—Epinal—Belfort, in 1914, gave the beaten 1st and 2nd French Armies the support necessary for them to hold up the Germans. Lille was surrendered without fighting, Rheims and Laon were evacuated, the quite obsolete Longwy, Montmédy, Les Aguelles fell to the German heavy artillery, Maubeuge held out for 13 days and thus contributed to the victory of the Marne ; the successful defence of Verdun ranks with the battle of the Marne in its decisive effect on the result of the War.

(4) *Russia.* The Russian fortresses were of ancient types, and so weak that the Russian plans did not contemplate prolonged defence. Nevertheless they fulfilled their purpose in serving as rally-points, in permitting the centre of gravity to be transferred, and even by a few days' resistance in enabling a beaten army to escape destruction.

(5) and (6) *Italy* and *Rumania.* These countries alone furnish no such example of permanent fortification serving its purpose as the foregoing.

Plan for closing the English Channel by means of Floating Towers.

Two floating towers, 120 feet high, 60 feet square, and accommodating a garrison of 100 men, were made in 1918 at a reported cost of £1,200,000 each, as part of a grand scheme for blocking the English Channel against German submarines by means of a steel boom. A picture of one of these towers appeared in *L'Illustration*, of the 26th February last.

Seeing in the Dark.

The British Army appears to be trying out an invention deserving of the greatest attention, which makes it possible in complete darkness to search for objects with infra-red rays and to project an image of the object, when found, upon a screen in ordinary light rays. The immense importance of such an invention can hardly be exaggerated, since the enemy can be fired at without any suspicion on his part that he is under observation.

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(SEPTEMBER–OCTOBER, 1927.)

The magazine surpasses itself in this number, which, in honour of the tenth anniversary of the great break-through battle, known to the Austrians as Flitsch-Tolmein and to the Italians as Caporetto, is devoted to Mountain Warfare. The number has been extended to 176 pages, and contains 10 photographs and 25 sketches. It was not considered necessary to include an account of the battle itself, but there is an introduction on the subject by Lieut.-Colonel Horstenau, the director of the War Archives in Vienna, which is followed by detailed accounts of subsequent operations, viz., the advance of the 9th Mountain Brigade, 5th–12th November, and the fighting for Monte Grappa, 13th–16th November. It was the preservation of Monte Grappa, after the disaster of Caporetto, which saved Italy from complete collapse: while the advance of the 9th Mountain Brigade, the turning movement from the north, is remarkable in that it reached the Monte Grappa before the Italians had had time to settle into their positions, and was then diverted, by orders from the Corps, at the moment when it might have rendered service of inestimable value to the attackers.

Other historical articles are Maj.-Gen. Lempruch's "The Capture of the Hohen Schneid," an account of fighting amongst glaciers, the experience of which "has altered all pre-war ideas on the subject," and two examples of attack and defence from the Rumanian front. The remaining articles are of a general nature. Major Mikulicz discusses the question whether it is better in mountain-warfare to attack by thrust up the valley or by capture of the heights, and answers that it all depends on circumstances, but generally both forms of attack are necessary. The whole subject of mountain-warfare is then very thoroughly covered by "Mountain-guns" (with 8 photographs); "The History of Mountain Troops"; "Mountain Troops of the German Army"; "The Military Importance of Mountain-climbing and Winter-sport"; "Machine-guns in mountain-country"; "The Use of Artillery in mountains"; while Reconnaissance and Observation Services, Engineers, Aviation, Tank attack and defence, all find a place; as does also an account of Austrian mountain-warfare literature.

Of the Engineers, Captain Regele says that, in mountain-warfare, communications are their first and most important task. Without them there can be no fighting at all, no materials can be brought up to fortify a position. He attaches great importance to artillery-formations having engineers permanently allotted to them, since nothing short of this will enable the guns to get forward and into action quickly, and even single guns, when they have been able to follow the infantry closely, have often proved decisive. Engineers must have their own mule or man-carrier columns, and, as their work is particularly exposed, they must have their own anti-aircraft defence. The need of Engineers is very great in mountain-warfare, so that there must be more of them in proportion to the other arms; but, in order to get the full value out of them, they must have had mountain-training.

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(NOVEMBER–DECEMBER, 1927.)

Salonica in the Great War. Captain Wisshaupt writes, in a pleasant, easy style, and yet giving chapter and verse for every important statement, the story of the development of the idea of attacking Salonica. He then considers the presumable advantages and disadvantages of such an attack, some of which are surprising. For instance, that the capture of Salonica would enormously increase Bulgarian territorial demands, to the embarrassment of their ally, Austria: that Entente troops released by the capture would certainly be transferred to the Western Front, while Bulgarian troops thus released could not be obliged, and would not be willing, to serve on any other front: that Salonica uncaptured would remain a threat to the Bulgarians, which would keep them faithful to their allies! In spite of these considerations he thinks that the Central Powers made a mistake in treating the Balkans as a subsidiary theatre, and that their front opposite Salonica was in reality a portion of their main front, as proved by events at the end of the War. Salonica should, therefore, have been captured.

The Development of Artillery Material in and since the War (continued). This instalment commences with "that indispensable artillery minimum of position-warfare and much-desired accompaniment of mobile warfare," the 6-in. How, of which the best example in the War was the 155-mm. *Canon Court* Schneider M 15. A short description is given of the British 6-in. Mk. I Howitzer, characterized as "a good and powerfully-built gun of good performance, but on the heavy side, and not so pleasing in appearance as the Skoda and Schneider howitzers."

6-in. guns and 8-in. howitzers are also dealt with, and descriptions are given of the Italian 260-mm. howitzer (Schneider), with the photograph of a battery, and of the German 42-cm. howitzer, with photograph. Two more good photographs are those of the new Danish 155-mm. Schneider-Howitzer L22, and a front view in the firing-position of the French (and American) 155-mm. G.P.F. Gun with Filloux splayed carriage.

Armoured Cars, by Major Heigl. The author deals with these under the headings: Characteristics and *Rôle*: Historical: Peculiarities of Construction: External appearance: Tyring: and shows himself to be just as accurate and full of information on the subject of Armoured Cars as he is on the subject of Tanks—or, indeed, of Artillery.

It is interesting to see a photograph of the first real armoured car, with four-wheel drive, complete armouring and machine-gun in revolving cupola, and to learn that this was offered to and turned down by the German Army in 1905.

In recounting the post-war services of the armoured car the author has omitted to mention Ireland, 1920–22, where, in action, in raids and round-ups, escort duty, patrolling, or even in carrying dispatches through country where a motor-cyclist dispatch-rider had no chance of arriving, the armoured car was invaluable.

(*To be continued.*) F.A.I.

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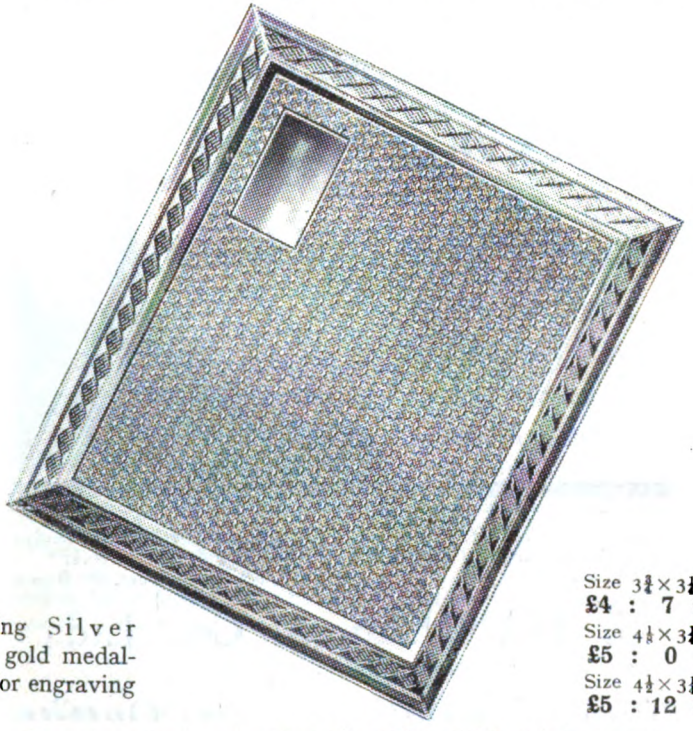

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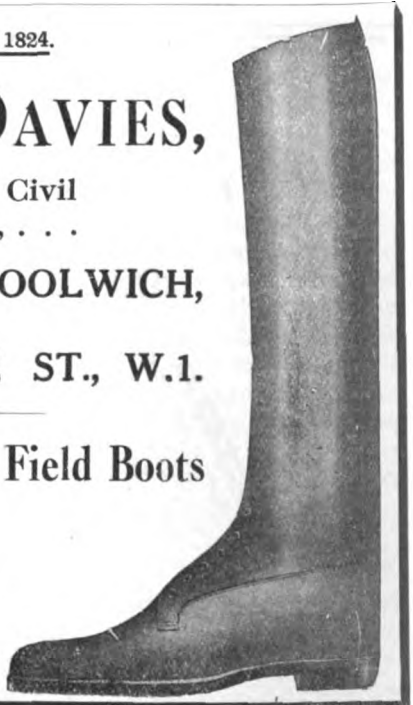

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ARTHUR FFOLLIOTT GARRETT PRIZE ESSAY, 1928.

SUBJECT SELECTED :—WATER SUPPLY ON ACTIVE SERVICE.

AN expedition is to be sent to the Crimea to capture the fortress of Sevastopol. Its strength and equipment are those of the British Expeditionary Force first landed in August, 1914 (4 divisions, 5 cavalry brigades, etc.), but local conditions are as in 1854. The expedition may land where it actually did, or at Balaklava.

You are requested to advise the C.I.G.S. as to the provision of water on and after landing.

An account of the topography and climate of the Crimea, with some notice of the water supply, will be found in *The Medical and Surgical History of the British Army which served in Turkey and the Crimea during the Russian War in* 1854–5–6, Vol. II, p. 15.* In general, in 1854–6, water was obtained from streams, existing wells and springs. This was sufficient in winter, but inadequate for 70,000 men and 10,000 horses in summer.

It may be assumed that, by sinking additional wells to sea-level, sufficient water may be obtained, except in July-August, when the streams nearly dry up and 20 per cent. must be obtained by condensing sea-water. Possibly some of the well-water near the coast will be brackish.

Any assumptions found to be necessary from want of *Engineer Intelligence* must be clearly stated to be such.

Essays must reach the office of the Secretary, Institution of R.E., not later than the **30th November, 1928.** Essays must not be signed, but each essay must bear a pseudonym, and the name of the writer, enclosed in a sealed envelope marked with the same pseudonym, must be attached.

The following are the conditions of the Arthur ffolliott Garrett prize :—

1. The prize, which will take the form of a piece of plate, to be chosen by the recipient, was instituted by Mrs. Garrett in memory of her late husband, Major Arthur ffolliott Garrett, O.B.E., R.E.

2. Qualifications of the recipient : To be an officer on the Active List of the Royal Engineers, not above the substantive rank of Captain on 1st January, 1928.

3. The essay must not exceed **10,000** words.

* By the courtesy of the Librarian, the book can be seen at the War Office Library *Professional Papers of the R.E.* have been consulted, but do not appear to contain anything on the subject.

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ATTENTION is invited to the conditions under which this prize, in value about £14, is offered for competition each year.

1. The Prize is awarded by the Council of the Institution of R.E. in the manner considered best for the encouragement of contributions on professional subjects, by R.E. Officers, to the Corps publications. It has been decided that the Prize shall be confined to Officers on the Active List not above the rank of Substantive Major.

2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography, or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie book-plate with inscription inside; (*b*) the remainder of the year's income of the Fund in cash.

The following are suggested as subjects for contributions:—

(*a*) Descriptions of works actually carried out in peace or war.
(*b*) Invention.
(*c*) Design (excluding works of defence).
(*d*) Labour organization on work.
(*e*) Scientific investigations generally.
(*f*) Accounts of exploration work and surveys.

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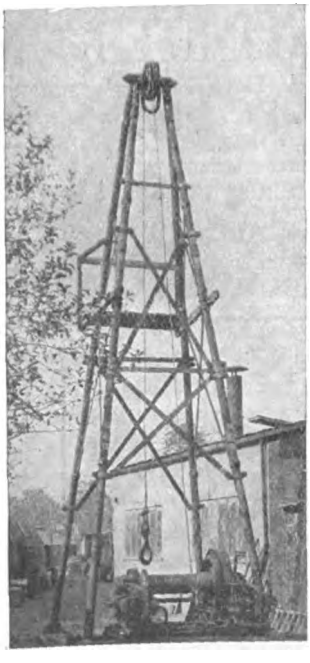

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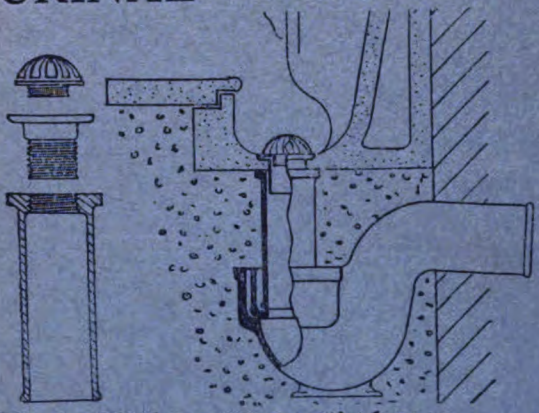

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When you adopted your title of Civil Engineers, a distinction was drawn between the "Civil" and "Military" branches of Engineering. As representing the military branch, the Institution of Royal Engineers cannot but recall, on such an occasion as this, the close co-operation which existed during the late war between all members of the Engineering profession.

In peace time, the Military Engineer must always be watching and aiding the progress of Engineering, so that advantage may be taken of inventions and ideas that may assist the nation in times of war, and he is therefore ever anxious to make use of the experience gained by your members in the very wide field in engineering science and practice covered by them. In a national effort in war your members will become Military Engineers in ever increasing numbers, bringing the weight of their experience to bear for the common good

The Institution of Royal Engineers therefore welcomes this opportunity of taking part in the celebration of the centenary of the Institution of Civil Engineers, with the earnest hope that the prosperity and usefulness of your Institution may continue to flourish, and that the cordial relations that have subsisted in the past between the two bodies of Engineers which we represent may continue in an increasing degree whatever the future may hold for us.

Signed on behalf of the Institution of Royal Engineers,

President.

Secretary.

Signed the 3rd Day of June 1928

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MEMORIAL TO LORD KITCHENER IN ALL SAINTS' CATHEDRAL, KHARTOUM.

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PRESENTATION OF AN ADDRESS TO THE INSTITUTION OF CIVIL ENGINEERS.

THE frontispiece shows the address presented by the Institution of Royal Engineers to the Institution of Civil Engineers, on the occasion of the Centenary Celebrations of the grant of their Royal Charter. The address was presented by Major-General P. G. Grant, C.B., C.M.G., President of the Institution of Royal Engineers, who attended the Celebrations as the delegate representing the Institution of Royal Engineers. It is printed in b'ack and red on vellum, and enclosed in a suitable case.

MEMORIAL TO LORD KITCHENER.

THE accompanying photograph of the Memorial to Lord Kitchener, in All Saints' Cathedral, Khartoum, has been kindly sent by Major-General H. J. Huddleston, C.B., C.M.G., D.S.O., M.C., G.O.C. the Sudan, together with the following description :—

The memorial is the work of Lady Helena Gleichen, and depicts the recumbent figure of Lord Kitchener being borne as for burial on the shoulders of representatives of the armies of Great Britain, India and the Sudan, whom he commanded in his various campaigns.

The group is in bronze, mounted on a marble plinth, and has an over-all height of 4 ft. 11 in.

Round the edge of the bier, and repeated again in large letters round the centre of the marble plinth, is the following inscription :— " The unresting giant, who above war's din held his grave course and laboured mightily, now beyond toil and clamour sleeps within the bosom of the eternal sea."

Round the bottom of the base is another inscription, which reads : " Earl Kitchener of Khartoum, K.G., K.P., O.M., G.C.B., G.C.S.I., G.C.I.E., Gov. R. Sea Litt., Sirdar E.A., C.-in-C. Exp. Khartoum, South Africa, India, A and C. Gen. Egypt, S. of S. for War."

The memorial, which stands in the south transept, where also are the windows erected in memory of Sir Lee Stack, was given by the Sudan Government to the Cathedral.

It was dedicated by the Right Rev. Bishop Llewellyn H. Gwynne, D.D., LL.D., C.M.G., C.B.E., Bishop of Egypt and the Sudan, and was unveiled by His Excellency the Governor-General, Sir John L. Maffey, K.C.V.O., C.S.I., C.I.E., on 5th February, 1928.

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Authors alone are responsible for the statements made and the opinions expressed in their papers.

THE RÔLE AND REQUIREMENTS OF AN ARMY CO-OPERATION SQUADRON.

A Lecture delivered by WING-COMMANDER O. T. BOYD, O.B.E., M.C., A.F.C., R.A.F., *at the S.M.E., Chatham, on March 1st*, 1928.

I HAVE been told to talk to you about the *rôle* and requirements of an Army Co-operation Squadron, but I hope that you will forgive me if I start with a digression, and a rather paradoxical digression at that.

What I want to say is that " while there are three types of squadron that co-operate with the Army, there is only one Army Co-operation Squadron."

I know that it sounds rather like the Athanasian Creed, but it is nevertheless a fact that I think is sometimes lost sight of.

The three types of squadron are :—

First.—Day and night bombing squadrons, who combine with bombing the duties of long distance reconnaissance.

The tasks of bombing squadrons allotted to an expeditionary force, just as much as those of army co-operation squadrons, are decided by the Military Commander, in consultation, of course, with the Senior Air Force Officer.

Next.—Fighting squadrons whose main duty is to seek out and destroy the enemy in the air and so to establish and maintain air superiority. In special cases, this type of squadron can be used to intervene more directly in military operations by attacking ground targets.

But it must be remembered that the primary *rôle* of the fighting squadrons is the maintenance of air superiority. If they are diverted from this *rôle*, the results of a possible loss of air superiority must be weighed up and accepted.

And finally, the army co-operation squadrons about which I am going to talk to you to-night.

Field Service Regulations is unusually emphatic when it says :—

" A military force will invariably be accompanied by army co-operation and long distance reconnaissance (day-bombing) squadrons. The number of these and the necessity for fighting and night-bombing squadrons will depend on . . . " certain factors, such as the nature of the campaign, and the composition of the enemy air force.

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Such squadrons as do accompany a field army will be placed under the command of the Military Commander-in-Chief, and form an integral part of his force.

I stress this point because I think that there is a danger that the soldier, even when well acquainted with the more intimate work of the army co-operation squadrons, is apt to overlook the important functions of the other squadrons that co-operate with the army—functions which, I shall endeavour to show later, have a vital bearing on the efficiency of the work of A.C. squadrons, and hence on the success of the campaign as a whole.

I apologize for this digression, and for the unavoidable confusion of terms, and turn to my legitimate task of discussing the "*Rôle* and Requirements of an Army Co-operation Squadron."

I think that the most logical way of approaching this subject is to consider, first, its *rôle*, and then the requirements that make the fulfilment of this *rôle* possible.

Army co-operation squadrons will normally be provided on the scale of one per Division in the field. They are not, however, divisional troops. They are usually placed under the command of Corps, and the Corps Commander will decide whether to sub-allot them to Divisions for certain operations or to retain them under his own control.

Broadly speaking, army co-operation squadrons exist to further the tactical plans of a commander. The vast majority of their work, though not all, is carried out immediately above, or a few miles ahead of, the front line or the foremost troops. The actual distance to which army co-operation aeroplanes penetrate depends on circumstances.

During the approach march, before contact with the enemy has been gained, they may, and probably will, be required to carry out medium reconnaissance. This type of reconnaissance will take them anything up to 40 or 50 miles in front of the army. At this stage of the campaign, it is practically certain that they would be working directly under Corps and not be sub-allotted to Divisions. Now, the broad principle of air reconnaissance, to which *Field Service Regulations* has given its blessing, is that a commander with aircraft at his disposal is responsible for obtaining information on all matters that would affect his own immediate plans. In the case of a corps, this would not be less than 40 or 50 miles during an approach march. In the case of a Squadron working with a Division, about 20 miles would meet the case. If, in the future, we find ourselves opposed to a highly mechanized enemy, these distances will, of course, be greatly increased.

The type of information that a pilot carrying out a medium reconnaissance would hope to obtain would be troops detraining, columns on the march, bivouac areas, and some indication of the enemy's

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mobile troops. He may also obtain valuable topographical information, particularly in an unmapped country such as Mesopotamia was during the war.

I think it will sometimes be useful if these topographical reconnaissances are done by staff officers with air experience, carried as passengers. They could then personally reconnoitre the route by which their formations will advance, the amount of cover available, the nature of the roads, tactical features and the billeting accommodation. Even the best maps are liable to be out-of-date and misleading.

If the enemy possesses an air force, medium reconnaissance would have to be carried out in formations of about five aeroplanes, flying together and mutually supporting each other.

A type of medium reconnaissance, to which I personally attach considerable importance, is one carried out about an hour before dawn. It is at that time that breakfasts are being cooked, and camping ground rubbish burnt, and there is a reasonable hope that the fires will give away the presence of troops who might otherwise remain concealed. I have seen good results from this method, during training at home.

While we are at this point, I would like to touch, for a moment, on the subject of night flying. The probable value of night reconnaissance is rather difficult to gauge in peace. We know that troop movements on roads are visible on clear moonlight nights from aeroplanes flying at quite low heights, and this form of reconnaissance can be practised. But in addition to this, we know that a great deal can be seen by dropping parachute flares from aircraft. Unfortunately, it is not practicable to carry out reconnaissances by this means under peace conditions. There are two reasons for this.

First, the incendiary effect of the flare, if it is still burning when it reaches the ground. During trials on Salisbury Plain, a haystack was accidentally set alight by a flare. As an illuminant, the result was excellent, but the method was unpopular with the owner of the haystack. Secondly, the flare and its parachute are dropped in a container, and, after falling a short distance—to allow it to fall clear of the aeroplane—the flare is expelled by means of a small bursting charge. The container, which is of quite appreciable weight, of course continues to fall, and would deal a knock-out blow to anyone it might happen to hit. Further, all pyrotechnics are notoriously unreliable, and a " dud " flare, falling in its container, would penetrate the roof of most houses. These two reasons debar the use of flares in peace. This is unfortunate, as they are certain to be used in war, and useful lessons may be overlooked.

There is just one point about night flying to which I should like to draw your attention. The pilots of army co-operation squadrons are trained to fly at night, and their aeroplanes are suitable for the work.

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At the same time, it is not their normal duty, and, if they fly at night, they cannot be expected to fly all day as well. An army co-operation squadron at war strength consists of three flights of six aeroplanes each, and with this establishment it is accepted that the squadron can keep three aeroplanes in the air throughout the hours of daylight. If much night flying is required, this number must be reduced proportionately.

Now I should like to turn to the more normal functions of the army co-operation squadron, and these fall into three main divisions: close reconnaissance—for which perhaps a more descriptive term is tactical reconnaissance; artillery reconnaissance, which includes the observation of artillery fire; and photographic reconnaissance. The relative importance of these functions will vary with the nature of the operations. While the situation is fluid and operations mobile, I have little hesitation in saying that close reconnaissance will be of primary importance, and artillery reconnaissance will be relegated to the background. As, on the other hand, the situation becomes more stabilized and operations static, the ever-increasing importance of artillery reconnaissance will be felt. Aerial photographs are likely to be demanded at all phases of a campaign, but it is in really stationary warfare that they will prove of the greatest value.

The duties of the close reconnaissance pilot are to carry out such reconnaissances of the enemy's positions as may be required by the Corps or Divisional commander, and to report the positions of our own and the enemy troops and any enemy movements seen. A fairly comprehensive task! It would be quite easy if the pilot could see all that some people are inclined to imagine that he can. It is often thought that it is only necessary to fly over a battle to see the whole thing spread out below you in neat little "packets," rather like the diagrams that one finds in books on military history, under such headings as "the positions of the British and French Armies at Waterloo immediately before the arrival of Blucher."

Unfortunately, it is not so simple. In reality, the pilot sees surprisingly little, and certainly does not get a *picture* of the battle. The sort of thing that he generally sees is the movements of small bodies of troops; signs of digging; suspicious-looking tracks leading into cover, which may denote the presence of tanks, or possibly only dragons, in the cover; a few gun flashes, denoting active batteries; some men outside a wood, which may or may not mean that there are many more inside; a group of officers standing outside an inn holding large white maps. This is certain to be the headquarters of a formation! Of course, every now and then, he gets a real haul, such as a column of troops on the march—possibly the reserve coming up—or enemy tanks moving in the open.

But all these little scraps of information—and there are lots of little scraps—are reported and marked on the general staff map of

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the formation with which the squadron is working. And so gradually a picture begins to emerge from little scraps received from the air and from little scraps received from other sources. Then as the picture forms, the commander and his staff can make deductions and draw deductions from each little scrap of information received.

And here I should like to remind you that it is a cardinal rule that the pilot must never attempt to make deductions. His duty is merely to report what he sees. He must never guess, even if he feels convinced that it is a 100 to 1 chance that his guess would be correct. The "guessing" must be done by the staff, who are in a far better position to do so. And this "guessing," or, to be more accurate, "deducing," can be far better done by staff officers on the ground than by staff officers in the air. It is my personal opinion that it is seldom or never advisable for staff officers to attempt to carry out tactical reconnaissance from the air. In the first place, it is rare to find a staff officer with sufficient flying experience to enable him to see anything like as much as a trained pilot. And again, there is a definite danger that he will attach undue importance to what he has actually seen with his own eyes, and be inclined to discount information from other sources which he did not happen to see.

There is another cardinal rule, this time one that applies, not to the pilot, but to the man who receives the pilot's report. And that is, "Never accept as reliable a negative report from the air." If a report is received from a cavalry patrol, that a certain village was not occupied at a certain time, it can be believed implicitly, as presumably the patrol has been there. But a report from the air that there were no signs of the enemy in a village, should be treated with the greatest reserve. It must merely be taken to mean that the pilot did not *see* any enemy, but, as he was obviously unable to go into the houses and look, they may have been there all the same.

I hope that anything that I have said has not conveyed the impression that I wish to belittle the value and importance of close reconnaissance. It is of vital importance, and helps enormously to dispel the fog of war, but it is complementary to the reconnaissance of cavalry and armoured cars. What I have been trying to explain is that it is not so simple and fool-proof as one might at first sight imagine it to be.

So far, in dealing with close reconnaissance, I have only considered reconnaissance of the enemy. There is, however, another side, though one that is, perhaps, of more importance in trench, than in mobile warfare. This is the locating and reporting of our own foremost troops during the course of a battle. The difficulty here lies in distinguishing between friend and foe when things have got mixed up a little in the course of the fighting. This identification difficulty has never really been solved. Theoretically, as laid down in *Infantry Training*, the foremost troops show identification signals at pre-

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arranged times, or on reaching certain positions, or when called upon to do so by the close reconnaissance pilot. The signal from the aeroplane—which is specially marked by flaps about a foot square hanging out from the rear edges of the lower plane—is a series of A's on a Klaxon horn, accompanied by the firing of several white Very lights. That is the theory, and it is all perfectly sound in practice, except that there is no satisfactory identification signal for the troops to show. *Infantry Training* refers to flares, white flaps or tin discs.

The flares are excellent from the pilot's point of view, but less popular with the man who has to use them. In the first place, they are of appreciable weight, and, as they are expendable stores, are apt to be expended prematurely by the overloaded infantry soldier by being thrown away. Again, they will not function when thoroughly water-logged, as was discovered during the Passchendæle fighting. And, finally, and this is the most unpopular feature of the flares, they are apt to expose the position of the troops who light them, to the enemy, as well as to the close reconnaissance pilot.

The flaps are pieces of white American cloth attached to the inside of the flap of the gas-mask container. They are of no value, as to see them a pilot has to fly so low, that he is able to distinguish between our own troops and the enemy without their assistance.

The tin discs are intended to be flashed in the sun. The sun has not proved a very reliable agent for communication lately.

So you see, a satisfactory solution to the problem of identification signals still remains to be found, and anyone who produces the solution will be doing a great service. Until a satisfactory type of signal has been devised, the pilot will have to fly very low to obtain his information, and the risks that he will run will be correspondingly increased. Close reconnaissance of our own troops, with the existing apparatus, had reached a high standard of efficiency by the end of the war. There is no reason why it should not be still as equally efficient at the beginning of the next war, but this does not lessen the desirability for finding a better signal.

So much for close reconnaissance. I should like now to say a few words about artillery reconnaissance.

This, as the term applies, is a form of co-operation with the air force which chiefly concerns the gunners, but I think that all officers should have a general idea of what it means.

The duties of the artillery reconnaissance pilot are to locate and report the positions of hostile batteries, to observe, for destruction or silencing, enemy guns or other targets, and to bring artillery fire to bear on hostile concentrations, troops, or transport, on the move. He does all this by means of wireless and a code, with the details of which I won't worry you. There are several variations of his task, and it all sounds rather complicated, but it is not so really. The important thing to notice is that here again, as in close reconnaissance,

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the pilot merely reports what he sees. He does not send corrections to the guns—he reports the fall of shells in relation to the target by means of the clock code. The battery commander applies the necessary corrections. He does not bring artillery fire to bear on targets, but merely reports the existence and nature of targets and stands by to observe fire on them if the C.R.A. or battery commander, who has taken in his wireless signals, decides to engage them. The allegation that is sometimes made, that the pilot *controls* artillery fire, is quite without foundation.

You may have noticed that, in speaking of reconnaissance, whether medium, close, or artillery, I have always referred to the pilot. This is because, in all classes of army co-operation work, the pilot does the observation. The passenger is carried entirely as an aerial gunner, to look out for, and help to fight, hostile aeroplanes.

There are several reasons for this. First, an aeroplane is a difficult thing to see out of ; the wings have a habit of getting in the way, and the only person, who can ensure that he can get an unobstructed view of an object on the ground, at a given moment, is the pilot. Flying an aeroplane, when well clear of the ground, does not require constant attention. A pilot has always a hand free, to tap a wireless key or write a message. Another reason is that, even if he were not carrying out the reconnaissance, a pilot would have to devote a good deal of attention to the ground, so as to try to get into the right place for his observer to see. Experience in France proved very conclusively that one man in a two-seater aeroplane should spend his whole time looking out for attacking enemy aircraft. Hence we have come to regard it as a principle that the pilot should do the observation, and I have never heard any serious doubts cast on the soundness of this principle by anyone with considerable war flying experience.

The last of the normal duties of the army co-operation squadron is photography. There are, as I have no doubt you all know, two types of aerial photographs—oblique and vertical.

Oblique photographs are taken from a low height, with the camera pointing at an angle of some 60 degrees from the vertical. The result is the same sort of view as one gets by standing on a high hill and looking out over the country. Vertical photographs are obtained by pointing the camera vertically downwards. The result is, of course, a map-like representation of the country. While the vertical photograph is really of more value, it takes something of an expert to read it. The oblique photograph, on the other hand, gives a very good idea of the topographical features of the country, and is very useful for letting troops know what sort of country they can expect during their advance.

By the end of the war, the demand for aerial photos was enormous, sometimes as many as a thousand being taken daily. During mobile operations, photography has its limitations. First, there is the time

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factor. The time between the ordering of a photograph and the delivery of the prints varies with such circumstances as the weather, the distance of the object to be photographed, the distance of the army formation from the squadron aerodrome, and the number of photographs. As a very rough guide, under favourable conditions, the time may be taken as between six and twelve hours. Another very serious limitation is the height of the clouds. Although this does not affect the taking of oblique photographs if the visibility is good, low clouds will prevent an area being covered by vertical photographs.

The main photographic task of an army co-operation squadron during a battle is the corps counter-battery area ; that is to say, the area in which hostile batteries are likely to be sited.

In addressing an audience such as this, I need not refer to the value of air photography as an aid to survey, except to say that, with the improvement of apparatus and technique—both in the air and on the ground—the potentialities are rapidly increasing.

Before concluding what I have to say about the *rôle* of an army co-operation squadron, I would like to offer a few suggestions as to the uses that Royal Engineers might make of aircraft

In unmapped and undeveloped countries, where water is likely to be scarce, or where the water supply is intermittent, air reconnaissance may be invaluable in reporting the presence, or otherwise, of water, and also on the possibility of the enemy being able to cut off the supply.

Again, in dealing with the passage of obstacles, whether natural or artificial, a short flight may often be the means of obtaining as much information as hours of travelling on the ground. For instance, it may be possible to say whether bridges have or have not been destroyed ; but I must warn you that this is sometimes more difficult than might at first appear to be the case. From a considerable altitude, the roadway of a bridge that has been blown, may often appear intact. The damage may only be discernible to a pilot flying quite low, or by means of a very large scale photograph.

It will often be possible to discover the existence of fords, by noticing that a road or track runs down to a river and emerges again the other side. This may, of course, denote only a ferry, but if it is, there will usually be some evidence, such as boats, landing stages, or the ferryman's cottage or hut, to indicate it. The depth, the strength of the current, and the nature of the bottom, must, of course, be ascertained by subsequent ground reconnaissances.

Obstacles on roads, such as craters, felled trees, or trenches, will usually be visible either to the eye or to the camera. Air reconnaissance and photography will prove invaluable in helping to decide how such obstacles can best be circumvented, and what material is available in the vicinity for repairs. The use of camouflage, either to

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conceal obstacles or stimulate obstacles, is perhaps worth considering.

In regard to survey work, not only will air photographs be invaluable for rapidly producing rough maps of unmapped country, and for supplying the detail for accurate maps, but a preliminary reconnaissance of an area may save hours of fruitless labour to survey parties, by determining the best routes for them to take. If the best value is to be got out of any of these reconnaissances, I think that it is often advisable that an engineer officer should be carried as an observer in the reconnoitring aeroplane.

In the time at my disposal, I think that that is all that I can usefully say about the *rôle* of an army co-operation squadron, so I will now try to sketch quite briefly the requirements of such a squadron.

First, as to the type of aeroplane that is suitable for the purpose. This is a two-seater, with the pilot in front and an aerial gunner behind. The pilot is armed with a fixed Vicker's gun, synchronized to fire through the propeller. The gunner has a movable Lewis gun. The aeroplane must afford the pilot a good field of view all round, and particularly towards the ground. It must be sufficiently roomy to accommodate the wireless set, camera, ammunition, Very lights, etc., that have to be carried. It must be able to stay in the air for three hours or more without refuelling, and must be able to land and take off from a fairly confined space. It must have a fair turn of speed, and, above all, must be "handy" in the air. An army co-operation pilot should not seek a fight, but he must be able to defend himself if attacked, and the "handiness" of his machine will be a great assistance to him in this.

But what he really depends on for his protection are the fighting and bombing squadrons, to which I have already alluded. It is their task to gain and maintain air superiority—the bombers by attacking enemy aerodromes, and the fighters by seeking out and destroying the enemy aeroplanes in the air. You notice I say "seeking out." It is no use waiting for them to come—the fighters must go and look for them. As was proved times and again in the War, a defensive attitude in the air is useless. The efficiency of the work of the army co-operation squadron will depend directly on the success obtained in the fight for air superiority. If they are to do their work properly, they must be reasonably free from interference.

This is why air superiority is so vital to an army in the field, and why *Field Service Regulations*, in discussing the duties of aircraft, says: "Among such duties and responsibilities, the *most important* will be the attainment and maintenance of air supremacy." The side that does not possess it is blinded and will be harassed by attack from the air; the side possessing it can do much to pierce the fog of war, and will be relatively immune from the menace of being bombed.

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Now let us turn to the ground organization of a squadron, and see what is required there. I have attached to your précis, as an Appendix,* an outline of the organization of an army co-operation squadron. From this you will realize that it is a fairly complicated machine. Like any other complicated machine, it should be protected from the weather, and should be moved about as little as possible. As regards housing, the provision of all buildings, hutments and works for the air force in the field, is undertaken by the Director of Works, so we rely very largely on the Royal Engineers for our comfort and thus for our efficiency. Of course, in war, comfort is a relative term. Although a front-line dug-out can never be as comfortable as a *château*, yet there are degrees of comfort even in dug-outs, and it is my firm conviction that, in the interests of efficiency, one should always be as comfortable as circumstances permit. From the air force point of view, I feel that this is doubly important. War flying is unquestionably a severe strain. I think that this is because the risks come in rather concentrated doses. Taken over a period during the war, it is surprising to find that few pilots exceeded an average of one hour's flying a day. Yet in that one hour, the risks, on the basis of casualties, were at least equivalent to those run by other arms in 24 hours. The more comfortable pilots can be made on the ground, the better they will be able to withstand the abnormal tension. To take another side of the case, photographs can be developed and printed in the special photographic lorries that form part of every army co-operation squadron, but the interior of a lorry is congested, and becomes intolerably hot in summer and bitterly cold in winter; better results will be obtained if a hut with water laid on can be made available. Similarly, an aero-engine can be overhauled in the open, but the work can be done more quickly and better under cover.

Of course I am visualizing fairly stable operations here. It is obviously impossible for us to expect much help from you in this direction when things are moving rapidly, and under such conditions we must take our chance with the rest.

But, however mobile the operations may be, it is most important that the ground organization of a squadron should be moved about as little as possible.

Let us say an army is advancing at the rate of 10 or 15 miles a day. There is no use in moving the squadron this distance. It is infinitely better to leave it alone, and let it make big bounds of 50 or 60 miles every four or five days. In the meantime, a series of advanced landing grounds are selected, in short bounds, keeping pace with the army. Aeroplanes can use these advanced landing grounds for landing on, to make reports, or to refuel and replenish ammunition and bombs, and can return to the squadron aerodrome at night for maintenance and adjustment.

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As it may fall to the lot of any army officer to have to select one of these landing grounds, and as I know of a good many instances where aeroplanes have been crashed through unsuitable landing grounds being chosen, I will try to explain exactly what is required. The site chosen should be about 400 yards square, not on a pronounced slope, and of a sound and fairly smooth surface. A grass field is the best, but beware of ridge and furrow, which will make an aeroplane bounce, and will probably result in a broken undercarriage. Stubble is quite good. Wet plough is hopeless, and will almost certainly turn a machine over; dry harrowed plough would serve. A very important point to look to is the approaches. If there are trees, houses or telegraph poles round the spot selected, the size will have to be correspondingly increased. As you know, an aeroplane lands and takes off up wind. The pilot may know the direction of the wind by smoke or something like that, but, on the other hand, he may not. To show him the direction of the wind, a T made of white cloth is put out, with the head facing into the wind. The pilot lands along the stem of the T. He will usually try to touch his wheels first on the T, so be sure that the going in prolongation of the stem of the T is good. It is also worth remembering that a landing ground should be accessible to 3-ton lorries.

Another important consideration in selecting an advanced landing ground for an army co-operation squadron is that it should be as close as possible to the headquarters of the army formation with which the squadron is working. Good ground communications between the squadron and the Corps or Division are vital. It is obviously useless for pilots to obtain information if it cannot be transmitted quickly to the proper quarter. The ideal is a direct telephone line to the headquarters concerned, but this can only be hoped for in moving warfare if the aerodrome or landing ground is reasonably close.

The communication difficulty is partially overcome by having direct communication between the aeroplane *in the air* and the headquarters. This is arranged for in the case of aeroplanes carrying out close reconnaissance by means of two-way wireless telephony. The reliable range of the sets used at present is only 10 miles, but this will, of course, be increased in time. In the case of artillery reconnaissance, one-way wireless telegraphy is used. Further, for medium reconnaissance, two-way telegraphy is used, the sets having a range of about 200 miles. So you see that a squadron has a good many different types of wireless sets to handle—to be exact, it has 62 sets, comprising six different types. A complicated component of the complicated machine! The wireless is supplemented by message-dropping, and, in cases where information about our own troops is concerned, this is the only safe way of conveying it, as it would be obviously undesirable to broadcast such information by wireless.

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As a method of communicating with the aeroplane when other means are not available, message picking-up can be resorted to. This is done by tying the message to a cord and suspending the cord between two poles, or rifles stuck into the ground by their bayonets, about ten feet apart. The army co-operation aeroplane has, as part of its normal equipment, a hooked stick hinged to the undercarriage, which can be allowed to hang down when necessary. The pilot flies low and hooks up the cord with the message with the stick, pulls it up, and reads it. It sounds crude, but works quite well in practice.

The ground communications of the R.A.F. are the responsibility of the Royal Corps of Signals, message dropping and message picking-up is a combined responsibility, and wireless communication between ground and air is an Air Force responsibility.

That is all that I have time to say about communications of an army co-operation squadron, but I hope that it is enough to give you an idea of the system and methods employed. Good communications, both on the ground and between the ground and the air, are a fundamental requirement of an army co-operation squadron. If communications fail, the squadron cannot possibly pull its weight, however well equipped, or highly trained, it may be in other respects.

To turn to one more point. Aircraft on the ground are very vulnerable, and require protection. Airmen are drilled and armed, and are fully capable of looking after themselves, but, as you know better than anyone, one cannot have it both ways. If an E. and M. Co. is put on outpost duty, the lights will probably go out. If an R.A.F. Squadron is required to protect its own aerodrome against sabotage during a period of unrest, or to picket the heights on the North-west Frontier while a breakdown party is collecting an aeroplane that has been forced to land, the aeroplanes will soon cease to fly.

In conclusion, I would like to refer to what is perhaps the most important requirement of all, and that is, that officers of the army should possess a sympathetic understanding of the difficulties and limitations of an army co-operation squadron. There is no black magic about it; it is all perfectly natural and straightforward. If you will allow me, I will close with a quotation from *Field Service Regulations*, which puts the point far better than I can hope to do :—

> " The full power of an army can be exerted only when its parts act in close combination, and this is not possible unless each arm understands the characteristics of the other arms."

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THE 23rd (FIELD) COMPANY R.E. IN THE GREAT WAR, 1914–1918.

(Continued.)

By MAJOR R. L. BOND, D.S.O., M.C., R.E.

PART II.—THE MARNE, THE AISNE, AND 1ST BATTLE OF YPRES.

Battle Honours during the period—" Marne 1914," *" Aisne* 1914," *" Ypres* 1914," *" Langemarck* 1914," *" Gheluvelt," " Nonne Boschen."*

DURING the night of the 5th/6th September, the welcome and eagerly expected orders were at last received for the advance to begin. The 23rd (Field) Company was allotted to the advance guard, the 1st (Guards) Brigade; No. 2 Section was detailed to move with the vanguard, the 1st Coldstream Guards. The vanguard moved out of Rozoy about 8 a.m., but had only marched about two miles when the enemy were encountered, apparently holding some farm buildings and surrounding hedges. The country was very open, and the battalion at once deployed in accordance with the pre-war training, into a series of lines, men being at about five paces interval. No. 2 Section wagons were placed under cover behind a small house, and the house, garden, and haystacks reconnoitred with a view to construction of a strong point in case the attack should be held up. There was some rifle and shrapnel fire, but few casualties were experienced, and, as the attack was apparently going well, No. 2 Section deployed and commenced to advance ahead of the reserve company.

All at once, for some reason that appeared incomprehensible at the time, orders were received to break off the fight and withdraw. The advancing lines turned about, and, still deployed, moved back towards Rozoy, followed by a few shrapnel. One man of No. 2 Section was slightly wounded. The withdrawing units began to catch up the leading battalion of the mainguard, which was also moving back, and a tendency for the troops to bunch in on the road became manifest. As the enemy was still following up with gun-fire, this seemed somewhat dangerous. No. 2 Section, therefore, lay down deployed, and when the road became clearer moved steadily back, finally marching in as if on parade, being complimented on their smartness and steadiness by the G.O.C. 1st Brigade.

After a long wait in Rozoy, the march recommenced, and was

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completed without further incident, the company bivouacking in an orchard at Le Plessis. Everyone felt much brighter, now that the movement was in the right direction, and the unit had proved its steadiness under fire sufficiently to draw the commendation of the exacting commander of the 1st Brigade.

The following day, the 7th, the march was without incident, by very cross-country routes, lanes and woodland tracks, to Le Trenois, again " a comfortable orchard bivouac," as the diary calls it.

On the 8th, the 23rd was again with the advanced guard, and there were strong expectations of coming into contact with the enemy. Actually, as the company following the Black Watch in column of route came to the crest of the hill, leading down to the Petit Morin, near Sablonnières, a shell, fired at long range, fell amongst the battalion stretcher-bearers immediately ahead, followed by several more on the right of the road. The wagons were rapidly got clear of the road, the sections deployed in accordance with a regular drill that had been worked out for such an eventuality, and moved forward to the cover of some buildings, where a considerable halt took place. The advanced guard was, in the meantime, fighting a sharp action by the stream, in which, however, the company took no part, and, as all bridges were intact, eventually continued the advance, getting into billets in a splendid barn on a high plateau south of the Marne, at Basseville Farm. This farm, almost an old manor house, had only shortly before been evacuated by the enemy, and the owner, to show his appreciation of our arrival, gave us an excellent dinner, and produced some of his mellowest *vin rouge*, which he had successfully hidden from his previous unwelcome guests. Shortly after the company got into billets a very heavy thunderstorm broke, producing one of the finest rainbows the writer ever remembers to have seen.

The next day, September 9th, was only a comparatively short march, the Marne being crossed at Nogent L'Artaud, where again the bridges were intact. There was some excitement at this point, as there appeared to be a considerable battle in progress to the west, about Château-Thierry, but it was difficult, even with glasses, to identify the columns of troops that could be seen on the move near that place. The march ended in a bivouac at La Nouette Farm.

On the 10th, the 2nd Infantry Brigade, the advanced guard of the 1st Division, had a sharp fight with an enemy rearguard near Priez, but the 23rd (Field) Company, following behind, were not involved. The Company billeted that night at Latilly, and the following night, after an undisturbed march, at Bruyères.

It must be remembered that, in 1914, although infantry units had " cookers," the high authorities took the view that the sapper could get on well enough without hot food, and these invaluable aids to morale were not issued to R.E. units. Neither did an officers' mess cart figure on the establishment. The latter need was supplied at

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Bruyères, where a fine black-hooded two-wheeled species of gig was purchased for 25 francs, and, drawn by a spare horse, was the most valuable possession of the Company, and the joy of that excellent cook, Corporal McCrory, until 1917. From time to time, most heartening signs of the hurried German withdrawal were apparent.

The 12th was a day of heavy rain; a long march over winding roads, descent into the valley of the Vesle by Mont Notre Dame, with its interesting old church, and a climb up the steep and muddy hills, brought the company to a most comfortable billet at Paars, a few miles south of the River Aisne.

The following day, the 13th, was to be the last genuine pursuit of the enemy that the B.E.F. was to enjoy for many, many a long day.

The company was early astir (breakfast at 3.30 a.m.) on the 13th; there were rumours that the enemy was counter-attacking, and a rapid reconnaissance of Paars produced a fair number of the long-handled shovels peculiar to the district, which were issued to the 2nd Infantry Brigade (the advance guard), which was busily digging in on the crest of the hills near Vauxcéré, overlooking the Aisne valley. The Company assisted. About 8.30, a message was received from the C.R.E. for two officers to go forward and reconnoitre the river crossings. Capt. Addison and Lieut. Bond rode forward and joined the C.R.E. and Adjutant in the shelter of a group of houses near the bridge over the canal south of Bourg.

Here the divisional cavalry, a squadron of the XV Hussars, were in action with enemy posted in the houses of Bourg. One or two troopers who had ventured into the open were shot. It was difficult, therefore, to get a view of the bridges, but by careful use of the nearby mill buildings and the bushes by the river bank, it was possible to discover that the main road bridge over the River Aisne, which at this point ran in a deep gully, had been demolished, but the attempt to blow up the aqueduct carrying the canal over the river had failed, and the wide towpath was passable for wheeled traffic. Closer inspection of the manager's house at the mill showed that the Bosche officers had had a hasty but complete breakfast, mainly of "bubbly," to judge by the débris, and were no doubt fully fortified for the battle. By midday, the cavalry and advanced troops had succeeded in making good their footing on the north bank of the river, and the Division then commenced to cross by the canal towpath. Owing to the nature of the banks and surrounding fields it was not possible to leave the towpath at once on crossing the bridge, but the column had to move almost a mile along the towpath to a point where a short deviation was made by the 23rd Field Company, leading on to the Bourg-Vailly road, a corduroy road being constructed of timber found near the site.

The towpath was hard put to it to stand the strain of the traffic, and the Company was fully employed in keeping the surface in con-

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dition, rapidly filling up holes with whatever material was handy, in the intervals between units, and suffering the objurgations of gunners temporarily held up by more than usually extensive repairs, whilst from time to time a long-distance shrapnel shell from the Chemin des Dames would fall with a sizzle into the water.

At last, however, the crossing was complete, and the 23rd Company, following after the column, moved up the long valley from Bourg, to bivouac for the night at the foot of the hill near Paissy. Sketch No. 6 is a somewhat indifferent panorama of the 1st Division battle-ground, taken from the Pargnan spur at the time.

It will be remembered* that, on the morning of the 14th September, the 2nd Infantry Brigade was ordered to seize the Chemin des Dames about Cerny, prior to the advance of the Divisional Advanced Guard, the 1st (Guards) Brigade. The 23rd (Field) Company moved with the latter at daybreak, but, before this, a tremendous outburst of rifle and machine-gun fire showed that the 2nd Brigade was already hard at it. The move by Moulins to Vendresse was not a comfortable operation, and the Company was fortunate in having no casualties from the increasing shell fire. After reaching Vendresse, there was no move for some time, and as the battle became more and more severe on the hill crest but a short distance in front, the C.R.E. ordered the Company to commence the construction of a rear line of strong points on the spur and curious sugar-loaf hill between Moulins and Vendresse. After digging the fire-trenches of these strong points, the sections manned them for a time, but about midday received orders to move to Paissy to carry out similar work. An excellent position was selected on the crest of the hill, and work was just commencing when the order was received to return to Vendresse, but no further work was required, and the Company went into bivouac at Moulins.

At 10 p.m., Nos. 2 and 3 Sections were ordered to assist the Queen's Regt., 3rd Infantry Brigade, who were in battle outposts on the Chemin des Dames, north-east of Troyon. The night was dark, it was pouring with rain, distances, as always, were deceptive, and also the run of the valleys and ridges, and it was only after prolonged reconnaissance that the Queen's were found, lying in an attenuated line along the small bank by the side of the Chemin des Dames road. The battalion had had a very heavy day's fighting, and the men were worn out and quite incapable of digging. It was, therefore, apparent that the best assistance the two Sections could give was to dig some cover for the troops to get into. A very considerable length of fire-trenches was dug some 80 yards on the enemy's side of the road, as it was obvious that trenches on the road must be a clear mark for hostile guns. The Sections provided their own patrols for security. Before finishing the work the parapets were camouflaged with turnips, the work being carried out in a turnip field. When complete, the

* *Military Operations, France and Belgium*, 1914. Vol. I, p. 341.

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Sketch No. 8.

BATTLE OF THE AISNE.

Panorama of 1st Division front, from Pargnan spur looking N.W.

(From Sketch made at the time.)

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nearest senior officer who could be found was informed of what had been done, and the Sections withdrew.

Some way to the left of our position, a haystack was burning fiercely, and throwing an eerie flickering light on the wet road and wet waterproof sheets, whilst a pervasive smell of burning straw soaked into the brain. There are no more potent remembrances than the senses of smell and taste, and the pungent smell of burning straw infallibly brings an instantaneous picture of that weird, wet, firelit battlefield flashing to the brain ; just as frying bacon conjures up visions of early mornings in the Cambrin trenches, and Staff College tea the chlorinated horror of a Zonnebeke pillbox.

Early on the morning of the 15th, the Company moved its position, owing to the unwelcome attentions of the enemy, but wherever a new pitch was staked out gunners appeared before and behind, soon to draw retaliation which made a further move imperative. All this time, the battle was in full swing about Cerny and Troyon, heavy losses were being incurred, and about 9 a.m. the situation appeared so serious that the 23rd (Field) Company was sent up to the 1st (Guards) Brigade to act as brigade reserve. The four sections, with bayonets fixed and magazines loaded, concentrated a short distance in rear of the attenuated firing line, which was in fair shelter behind a bank on the near slope of the hill. However, the anticipated attack failed to materialize, and the situation becoming more satisfactory, the Company withdrew to billets at Moulins. Here it remained during the following day, except for No. 4 Section (Lieut. Stafford), which moved to Villers to assist the 1st Field Squadron in the repair of bridges at that place.

From this date commenced trench warfare, and it will be desirable to indicate in general the work and method of employment of the Field Company, rather than follow its fortunes day by day.

First of all, however, in order to realize the conditions under which the hard lessons of trench warfare were slowly learned, the doctrine of the organization of defence at this period must be understood. The defensive had received a good deal of study in the couple of years immediately preceding 1914. In the summer of 1913, the 1st Division at Aldershot had carried out a 24 hours' working party exercise, at full strength, in the Mytchett area, in the construction of a defensive position on a front of about 4,000 yards.

The scheme of defence, based on doctrine of which the C.R.E. 1st Division (Lt.-Col. A. L. Schreiber, D.S.O.) was the chief apostle, consisted of a series of strong points, mutually supporting, carefully sited to economize numbers and ensure the best field of fire, and camouflaged from ground observation, even to the extent of removing clumps of trees and replanting them in front of the trenches. The support companies were to be in similar works in rear.

Each defended locality, or " point d'appui," as it was called (an

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unfortunate term which, overworked, became a source of some ribaldry amongst the lesser fry), consisted of three or four separate lengths of normal three-task fire-trench, with a few yards' interval between each, but in principle on the lines which proved entirely sound in the course of the War. The position as a whole had not any great depth, the reserves not being entrenched, but kept concentrated and mobile. The Field Companies were employed on the lay-out of the defences, issue of tools, supply of guides, construction of overhead cover, and the " camouflage " of trenches, though the word did not come into use until much later. The principle of the strong point and supporting point was therefore well understood.

As a result of the fighting on the 14th and 15th September, 1914, the 1st Division, after suffering heavy losses, found itself lying in a long thin line ; on the right, along the edge of the Chemin des Dames, then bending back on the reverse slope of the crest between Cerny and Troyon, behind a low bank formed by a sudden change of field level, which ran for a considerable distance along the Chivy spur. Behind this bank the attenuated platoons had found effective shelter from the enemy's artillery fire, and so rapid and accurate was our rifle fire that enemy attacks were wiped out even in the short field of fire between bank and crest. Here the men dug themselves in, first into one-man holes, then into continuous narrow trenches, for which the Field Companies were soon to provide much-needed traverses.

Digging in in this manner, every man fired straight to his front, and as there were practically no troops available behind the front line, it was soon found that any gap in the line, even of 100 or 200 yards, was apt to be discovered by the enemy, especially at night, with the most unfortunate results. Everyone's energies were therefore concentrated on ensuring that no gaps occurred. So far as the forward defences were concerned, our friend the *point d'appui* was a thing of the past. Nevertheless, under the instructions of the C.R.E. a number of strong points were constructed by Field Companies on important features further back. The 23rd (Field) Company spent several days in the construction of a true defended locality at Pargnan, also at Paissy, and on the Moulins spur. The Paissy locality was commenced on the night of a serious break in front due to the unduly early withdrawal of an Algerian battalion on the right. The situation was restored, after some anxious moments, by General de Lisle's Cavalry Brigade, and the eventual arrival of some units of the 18th Infantry Brigade. The commanding officer of one of these battalions was much attached to an antique pipe, which he unfortunately dropped in the course of his reconnaissance. The writer spent a remarkable twenty minutes assisting in the search, crawling on his hands and knees amongst the overgrown beet in the light of the stars well in front of the forward infantry line. The faithful briar, unhappily, was not to be found.

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After the first ten days, a system was inaugurated of two sections living in forward billets at Vendresse, the remainder of the Company being kept in reserve. The forward sections at first were employed on traversing fire-trenches, improvement of a second line of trenches which were now beginning to appear, in sapping in typical siege-warfare fashion to get trench lines in certain places nearer the enemy, and the construction of wire entanglements along the front trenches—the latter a somewhat ticklish task, as any small disturbance led to a rapid outburst of fire from both sides, until we insisted on hostages from the infantry coming out with the wiring parties. Screw pickets were not invented, and wire was mainly of the low variety, laid three bays wide, muffled mauls being used; though the irrepressible wit who invariably fell over spare coils, hit other people on the thumb, and then laughed at his rotten joke, made these efforts at silence of little value. However, by marvellous good fortune casualties were rare.

During this period, H.Q. and the rear sections were billeted in Bourg, but for two days the Company moved to Villers, where Nos. 3 and 4 Sections were employed in strengthening the barge bridge to enable it to take heavy transport. This was effected by building up crib piers close to the gunwales on either side of each barge to replace the central transoms, thus doubling the number of transoms throughout the bridge.

One cannot leave this account of the work done on the Aisne without reference to the first efforts in field survey carried out by the O.C., 23rd (Field) Company. Maps were not sufficiently accurate for "predicted" shooting, but very soon after trench warfare commenced "R.B." was at work with his plane Table. The first essay was in fixing the positions of a field-gun and a machine-gun so that they could fire in enfilade down a road leading to Cerny, which it was apparent the enemy would be bound to use for transport at night.

Later on, the survey was extended to fixing the positions of the 6-in. howitzer batteries, O.P.'s and so on, a much-needed work, for, as invariably happens in peace and war, the battle was fought on the edge of two maps, one of which was the French hachured article, the war having tactlessly gone beyond the boundary allotted to it by our G.S.G.S. of 1914.

On the 15th October, the French took over the 1st Division line, the 23rd (Field) Company maintaining an observation party on the Bourg bridge during the withdrawal. No. 4 Section came in from Vendresse during the day, and from Stafford's lurid account of the day's doings, the Company forward billets had ceased to have any attraction.

At 6 a.m. on October 16th, H.Q. and Nos. 1 and 2 Sections marched to billets at Perles, Nos. 3 and 4 going to Pont Arcy to dismantle a pontoon and trestle bridge at that place. They rejoined at 8.30 p.m.

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Nos. 1 and 2 Sections moved to Pont Arcy at 7.30 p.m. to dismantle the main pontoon bridge of, writing from memory, 12 piers. The French had not yet completed their bridge, and it was not considered advisable to remove our bridge until the French communications were satisfactory. Work was not commenced until 11.30 p.m., and owing to the pontoons having been in the water for a month, the river running fairly fast, and the narrow lane approaching the bridge being steep, cobbled, and slippery, it took till 1.30 a.m. to dismantle the bridge and pack wagons. These Sections rejoined at Perles at 4.30 a.m., on October 17th, having marched 27 miles during the previous 24 hours, and dismantled the bridge. The day's rest on the 17th was, therefore, fully appreciated. At 2 a.m. on the 18th, the 23rd (Field) Company entrained at Fismes ("side loading on to end loading trucks as usual," says the diary), the Battle of the Aisne was over, and the curtain was now to ring up on even more stirring deeds.

That the Sappers had taken their full share of the work is evinced by the following message to the C.R.E. from the G.O.C., 1st Division: "Please congratulate the 23rd and 26th Companies under your command on the excellent work done by them during the Battle of the Aisne, which lasted 31 days. The skill and courage shown by them in strengthening the infantry trenches night after night, and often under fire, reflected the greatest credit on all ranks of the two Companies. The infantry who benefited by their skilled work greatly appreciated their assistance."

YPRES, 1914.

The 18th October and the greater part of the 19th were occupied in the train journey to the north, passing through the outskirts of Paris, thence by Amiens and Boulogne to Cassel. The journey was slow, there appeared to be trains 200 yards apart all along the line, and it was no difficult feat to get out and walk, or even to stop and indulge in a hasty wash at a stream, catching up after a short run. On detraining at 8 p.m., the Company marched back to billets at Hazebrouck.

On the 20th, the Company, marching at the rear of the Division, billeted in the big brewery at the west end of Poperinghe—a very fine billet for all ranks. The officers remember with gratitude the excellent dinner provided by the manager and his wife, the liberal cellar, and the subsequent entertainment, for both host and hostess sang delightfully. This house escaped injury throughout the war.

The 21st was once again a day of battle, for the Division, moving on Poelcapelle, met the enemy about Langemarck. The Company, though ordered up at 1 p.m. to the neighbourhood of Pilkem, was not engaged. The Sections moved up at 8 p.m. to the front, to assist the 1st (Guards) Brigade by clearing the field of fire, but work had barely commenced when dispositions were changed, and the Guards batta-

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lions took up a line further in rear, on which no assistance was required at the time, wire not being available. The Company billeted for the night near Pilkem.

It will be remembered that on the following day, the 22nd October, the heavy fighting of the Battle of Langemarck took place, the attack of the German Fourth Army on the 1st Corps and 7th Division. The Yser canal ran along the whole length of the rear of these formations, and as there was no bridge between Ypres and Boesinghe, a three-and-a-half mile stretch, any forced retirement would have caused the most serious difficulties in withdrawal of guns and transport. The 23rd (Field) Company was, therefore, ordered to construct a bridge half-way between the above places.

By good fortune, at a very good spot, two large barges had been abandoned. These had been swung across the canal and a footbridge constructed across them. As the approaches to the canal by these barges were as good as could be found, work was at once commenced on a medium bridge. Sketch No. 7 shows details of construction. It was found that the ordinary mud shoes on the Weldon trestle legs did not prevent undue sinkage in the mud of the canal, and fascines were, therefore, bound longitudinally under each pair of legs, in a manner tried out at the bridging camp in the early summer, and gave excellent results under full loads.

Work was continued in shifts night and day, and was completed in 29 hours, by 5 p.m. on the 23rd. A considerable amount of work was carried out on the approaches owing to the height of the canal banks. Small subsidiary bridges over a couple of streams were also constructed. Work was interrupted during the night by orders to move to Boesinghe and occupy a position there, but on arrival the trenches were found tenanted by the 2nd Infantry Brigade, and the Company returned to work.

The 24th was spent in putting finishing touches to the work. The G.O.C. I Corps (Sir Douglas Haig) and his B.G.G.S. inspected the bridge. Although, happily, the necessity did not arise for urgent use of the bridge, it provided admirable bridge-crossing practice for a squadron of French Chasseurs, who made the passage some seven or eight times in the day. The horses became quite tame after the fifth round.

The 25th was a day of rest, and arrangements were made to hand over the bridge to a Company of French Engineers, after removal of bridging equipment.

Sketch No. 8 illustrates the activities of the Company during the forthcoming operations.

On the 26th, the Company moved through Ypres to a *château* about 1½ miles out, on the Menin road, where it was in Divisional reserve with the 2nd Infantry Brigade. Some work was done in the preparation of an aerodrome for the Royal Flying Corps.

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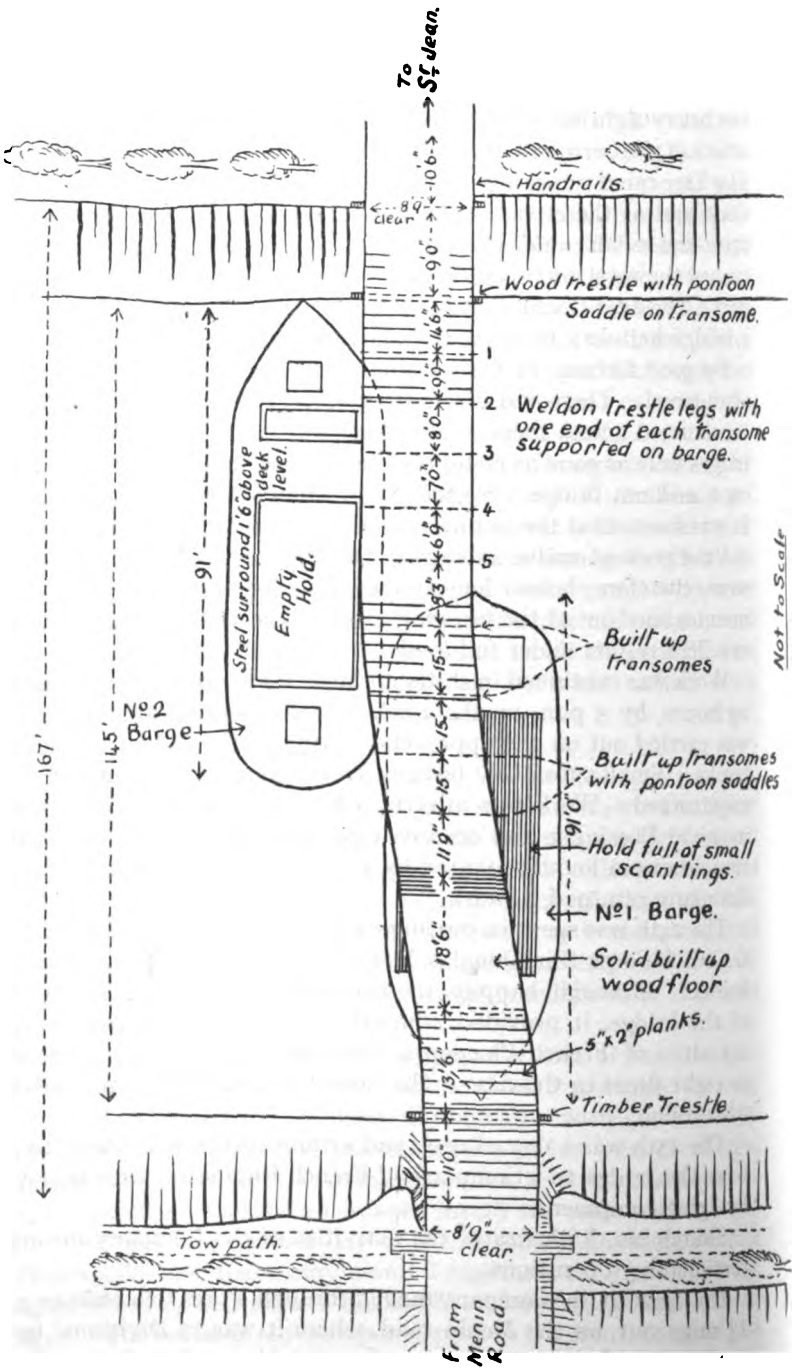
SKETCH OF BARGE BRIDGE OVER YSER CANAL. Sketch No. 7.

23rd (Field) Company, R.E. Oct. 22nd-23rd, 1914.



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The 27th provided a strenuous day's work. The Company moved forward to a bivouac beside the grounds of what was afterwards Stirling Castle. From 1 p.m. to 6 p.m., the Sections were employed in improving the communications through the Herenthage woods towards Gheluvelt, communications urgently required for the movement of artillery ammunition wagons. The Menin road was already becoming thoroughly unhealthy, and alternative routes were lacking. The work consisted in making a bridge over the Basseville stream south of the *château*, completing a corduroy road through the wood leading to Gheluvelt, and erecting notice boards. At night, the sections moved forward to the Kruiseeck cross roads, to assist the 1st (Guards) Brigade. An attempt was made to strengthen the group of buildings at the cross-roads, by the erection of a wire entanglement, but the small quantity of wire available made this an indifferent obstacle. The existing barricade was improved, and some assistance was also given to the Scots Guards in the construction of communication trenches. Sections returned to bivouac at 3.30 a.m.

After a day spent resting, so far as intermittent shell-fire would allow, in bivouac, the Sections again went forward at 6.30 p.m. to assist the 2nd Infantry Brigade to strengthen the defences of Gheluvelt. Each Section worked on a definite strong point. There was a good moon, and it was not difficult to site trenches fairly satisfactorily. Working strength of Sections being about 30 N.C.O.s and men, it was not possible to achieve a great deal, the work usually consisting of digging some six 15 ft. bays of fire-trench 3 ft. 6 in. deep, with as much protective wire entanglement as the material available would allow. Passages were also cut through the thick-set hedges surrounding the cottage gardens, to give free passage for the movement of troops. One good-sized garden had given place to what appeared to be two mine craters; these turned out to be shell holes from the enemy's new 13-in. howitzers, and the impression of this new form of frightfulness was somewhat distasteful. Sections returned to bivouac at 2 a.m. Again the Sections moved up to Gheluvelt at 6.30 for work with the 2nd Infantry Brigade of a similar nature, returning to bivouac at 2 a.m. on the 30th.

The 30th October was the day of the great German attack by Fabeck's newly arrived army group on the emaciated remains of the I Corps, 7th Division, and 7th Cavalry Brigade. The attack fell heavily on the two latter formations about Zandvoorde,* and at 1 p.m. the 23rd (Field) Company, R.E., was sent forward to join General Bulfin, who with two battalions of the 2nd Infantry Brigade was taking up a position along the southern edge of the Herenthage Château grounds. The 23rd (Field) Company arrived here about 3 p.m., and at once commenced to assist the Sussex and Northampton-

* *Military Operations in France and Belgium*, 1914, pp. 277–8.

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shire by digging trenches along the edges of the wood. The work was slow, owing to the roots of the trees, cutting tools being required. The various Sections became detached, each doing whatever work could most assist the infantry companies they were with. The Sappers dug steadily until 9 or 10 p.m., whilst the woods nearby were heavily shelled. Three Sections collected about 11 p.m. under the O.C. and received orders to dig in and defend Groenenberg Farm. No. 2 Section, in the process of withdrawing on the completion of work, ran into General Bulfin, and was at once ordered to assist the 2nd Gordon Highlanders, who were taking up a position to the east of Groenenberg Farm. The battalion was discovered lying along a field track in an open, ploughed field on a slope falling gently towards the enemy, the officers and men dead-beat, and most of the latter fast asleep. It was apparent that, if no trenches were dug, little would be left of the battalion next day, but the men were obviously too done to dig at all. No. 2 Section therefore set to work, and the Sappers, who had already dug for seven hours, completed an excellent trench in the easy soil sufficient to hold 40 or 50 rifles, adjoining the wood on the left of the line; subsequently this section rejoined the others at Groenenberg Farm. The O.C., with Nos. 1, 3 and 4 Sections, were hard at it digging in round the farm, patrols being sent forward two or three hundred yards without finding any enemy. No. 2 Section was sent to thicken the Irish Guards' line to the west of Groenenberg Farm, where once more the Sappers commenced work on their fifth lot of trenches, in the light of a bright moon. However, about 3 a.m. on the 31st, two Companies of the Oxfordshire and Buckinghamshire Light Infantry arrived, and took over the defence of Groenenberg Farm, a very weary Field Company finding its way back to billets in the stables of Hooge Château.

The story of the great battle round Gheluvelt on the 31st is well known. At 10 a.m. the Company was ordered to move up to man trenches north-west of Veldhoek, but this, and a further message to the same effect at 11.45, were cancelled, and a commencement was made with a trench line on either side of the main road about what was afterwards Clapham Junction.

The position at and south of Gheluvelt was now becoming obscure, and at 1 p.m. the Company received orders to move forward on either side of the road to clear up the situation. No. 2 Section moved forward on the north of the road through the Veldhoek Château grounds to the Veldhoek cross-roads, where General Fitz Clarence (commanding 1st Guards Brigade) was encountered. He ordered this Section to dig in and prepare to defend a house and garden just north of the cross-roads. However, the great counter-attack of the Worcesters having restored the situation, this Section was unmolested, and suffered no casualties from the occasional shell-fire. Nos. 1, 3 and 4 Sections, under Captain Addison, struck further south, and had a

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successful afternoon, turning some Germans out of a house, and rescuing a field-gun, of which the team had been knocked out by a shell. All four Sections returned to billets at Hooge Château at dark.

The following day, as a result of the catastrophe to the 1st and 2nd Division H.Q. at Hooge Château, the Section commenced the construction of a large cut and cover dug-out under the shelter of a house at the west end of Hooge, to act as a Divisional H.Q., and the work was continued on the two following days. The Company suffered a serious loss on the 1st November, a shell falling in the horse lines just outside the mounted men's billet in a farm. Several horses were killed, and six drivers hit, of whom two died later; billets were therefore moved to Rifle Farm, near Hellfire Corner, where they remained for the rest of the battle.

On the nights of 1st and 2nd, the Sections were employed wiring in front of the 1st Guards Brigade line at Veldhoek, and, as wire was now coming up fairly well, quite respectable entanglements were constructed. Each night, on the way forward, the Company officers looked in at Brigade H.Q.; an outstanding and happy memory of that strenuous and desperate time, when every visit to the front line found another good friend of the Aldershot days lost, was the wonderful atmosphere of confidence and good cheer ever to be found in that H.Q., sending us on to work feeling strengthened and refreshed at contact with so high and courageous a spirit.* Every officer and Sapper felt it a peculiar honour to work for such a Brigade.

On each of these days there was heavy fighting about Veldhoek, and each night the Sections went forward to wire the new front.

On the afternoon of the 3rd November, the C.R.E. reconnoitred the line, deciding on the position of a number of strong points to be constructed that night. For the first time, instead of the desperate hand-to-mouth patching up of the front line here and there, a considered scheme of supporting points was to be constructed, and to meet with its due reward.

Sketch No. 8A shows the details of the work carried out by three Sections of the 23rd (Field) Company under the O.C. on this night. These works were commenced and made good progress on the night of the 3rd/4th November, and continued on following nights. Work was also commenced on a dug-out for Brigade H.Q. at Fitz Clarence Farm. On the nights of the 5th and 6th, first one, and then two Sections were allotted to the 6th Cavalry Brigade south of the Menin road to improve communications through the Herenthage Château grounds.

On November 4th, Captain Addison left the Company to become Adjutant, R.E., 1st Division.

* Brigadier-General Fitz Clarence, V.C., his Brigade-Major, Major (now Major-General) C. E. Corkran, and Staff Captain, Captain (now Colonel) A. F. A. N. Thorne.

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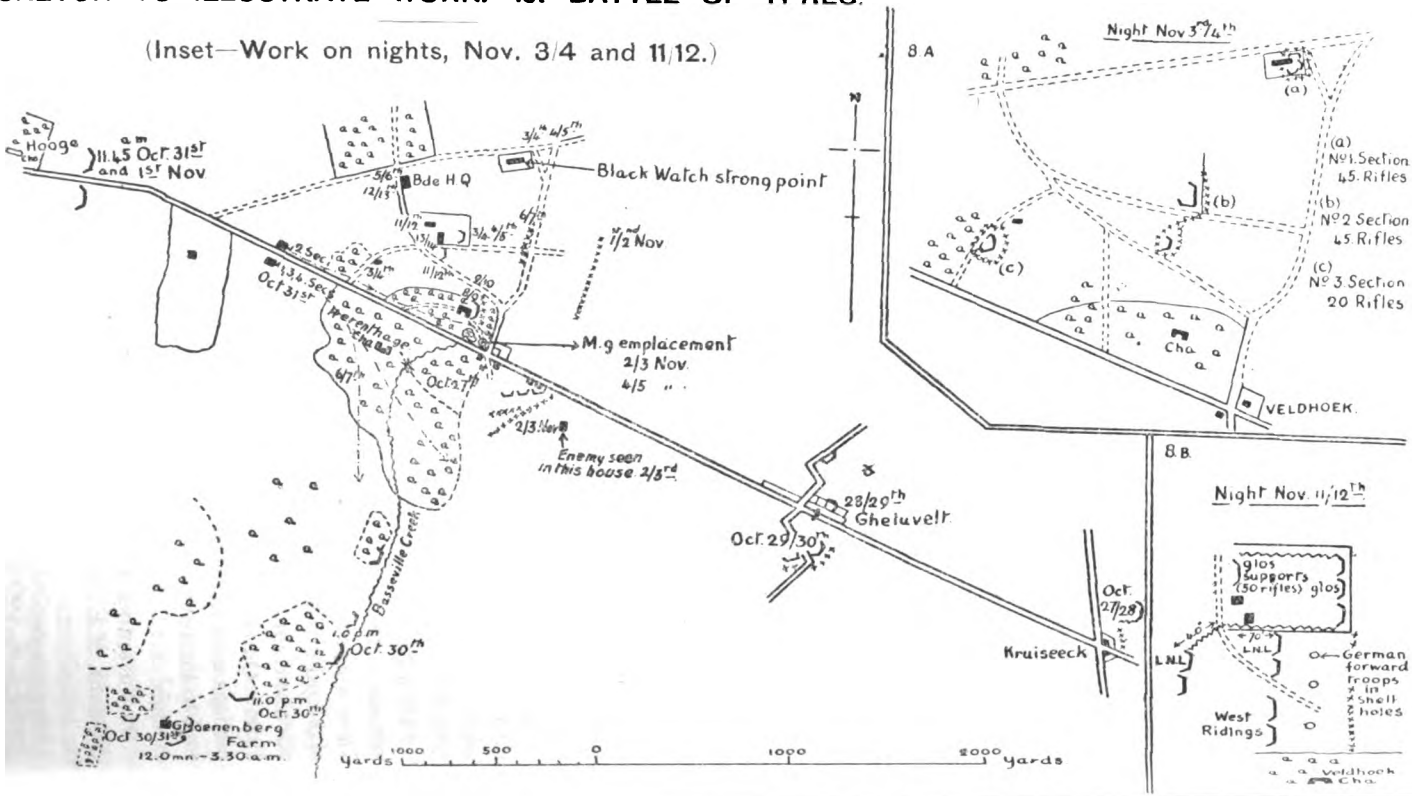
Sketch No. 8.

SKETCH TO ILLUSTRATE WORK. 1st BATTLE OF YPRES.

(Inset—Work on nights, Nov. 3/4 and 11/12.)



On the night of the 7th November, the whole Company was ordered to Ypres, where hostile shelling had started more than one fire. The whole of one side of the main square was in a blaze, and it was obviously out of the question to do anything with that, but in two or three other places fires had barely commenced, and these were put out without serious difficulty. Just after midnight, it was noticed that a fire had started in the scaffolding round the Cathedral tower, which was under repair. Officers and men rapidly scaled the ladders to the topmost platform, where a sack of shavings was starting a fine blaze. Luckily the workmen had left behind a bucket half full of water, and with this, and the contents of waterbottles, the fire was soon extinguished.

The sight from the top of the tower was unforgettable. Far below, the blazing square, throwing into strong relief the, as yet, untouched Cloth Hall; all round the horizon, and as far as the eye could reach, the continual flash of guns, and intermittent brilliance of German Very lights, and from time to time, away in the direction of Menin, a tremendous flash, followed, after a long interval, by a deep and liquid note, rising to a roar, as a 12-inch shell plunged into the city below, making one feel as if the tower was about to be swept from beneath one's feet.

During the 8th, a Company of Zouaves, who had been holding a house just outside the Veldhoek Château grounds, were driven in, and the situation was somewhat uncertain. The whole Company moved up at night to dig and wire a new line through the grounds. Thanks to R.B.'s careful reconnaissance, and gift of extracting the last morsel of information from anyone on the spot, the Sections were saved from endeavouring to put up wire in front of a trench already occupied by the enemy. This work was continued on the 9th. Very large heavy loop-hole plates were utilized for the construction of machine-gun emplacements, but they seemed somewhat unwieldy. Overhead cover had also not yet died a natural death; we had still to learn that the earth parapet was the best defence against the H.E. shell.

On the night of the 10th, all four Sections were again at work with the 1st (Guards) Brigade, completing strong points and adding communication trenches.

The fruits of this work were abundant on the morrow, for the grand attack of the Prussian Guard, after piercing the thin front, was held up with the heaviest loss by the strong points, in particular that at Black Watch Corner, where the thick hedge had been well wired, and the whole prepared for all-round defence. Nevertheless, the situation was precarious, and the Company at one time, 2.55 p.m., was ordered to move forward to act as infantry, but was recalled a short time later.

At night, all Sections were employed on wiring and trench work in

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the Château grounds, and in construction of communication trenches to improve a strong point occupied by the Gloucesters. A wire entanglement was also erected from the Gloucesters' strong point to the Château grounds.

On the following night, the Gloucesters, with great glee, informed the Company that, when morning broke, it was found that a number of the enemy had dug themselves in between the strong point and the Château grounds, and we had *wired behind them* in the rain and darkness. (Sketch 8B.)

During this day, heavy shelling of the back areas had taken place, and, amongst others, the Company horse lines had a severe time, several horses being killed. Nevertheless, Driver Bianchi, who had barely completed his recruit training in August, walked up and down, calming the frightened animals, adjusting footropes, and by his courage and devotion to duty undoubtedly saving more losses, and for his gallantry was awarded a well-earned D.C.M., the first honour in the unit.

On the 15th, no work was carried out, and orders were received for the 23rd (Field) Company to move at 11.30 p.m., and march to Vlamertinghe. An unfortunate catastrophe now occurred. The enemy by ill luck found the billet, dropped the first shell into the sleeping No. 3 Section, causing one fatal and eight severe casualties (rapidly and admirably dealt with by Captain Irvine, R.A.M.C., by the light of a stable lantern), and a second fell in the wagon lines killing several horses, including Stafford's delightful mare, "Lady." After this, the Company got under way, and it was with great thankfulness that Ypres was put behind, and, marching first to Vlamertinghe, then to Westoutre, and finally to Borre, came to rest at the hospitable farm of the Famille Oudinot.

On the march to Westoutre, an R.A.S.C. train wagon in charge of a very young and chubby officer was encountered, having skidded on the *pavé*, and stuck with its hind wheels in the mud. On the further side was a complete French Divisional staff in a column of cars, in the leading car a delightful white-haired old general, working himself into a state of purple fury at the obstruction. Our chubby friend, however, doing his best, beamed on the explosive old gentleman, and, in the most tactful manner, said: "Calmez-vous, monsieur, calmez-vous!"

(*To be continued.*)

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WITH THE SHAFORCE, 1927

By LIEUT. E. S. de BRETT, R.E.

My job at Chatham was just at an end, and at 12.45 p.m. on Saturday, the 22nd of January, I had just completed discussing with the Adjutant the arrangements for my future. These being satisfactorily fixed, I proceeded to the Mess, feeling pleased with the world in general and my lot in particular. At 1 p.m. I received a War Office telegram instructing me to report at Eastern Command H. Q. immediately for service in China. In twenty-four hours I was out of Chatham, and in seven days was on board the *Kinfauns Castle* en route for Shanghai, in company with those of the Staff who had not gone on ahead on the *Megantic*, Major Witts, McCandlish, Wilson, the H. Q. personnel, and the 2nd Bn. of the Coldstream Guards. This was a fairly sudden departure, but could not be compared for speed with the rapidity with which some people had to get on the move.

We had an enthusiastic send-off, both from Waterloo and Southampton, where the proceedings were further enlivened by the successful effort at desertion of a drunken stoker, who dived overboard at the last minute, and evaded all efforts at recapture till the ship was well under way. My last impression of Southampton was of a line of people with hands linked, singing "Auld Lang Syne," and of a bedraggled stoker shaking hands with himself, and dancing unsteadily on a raft.

The voyage was uneventful save for the weather in the Bay of Biscay, where we struck the tail end of the storm which drove the *Assaye* to shelter. We made very good time, arriving in Hong Kong harbour thirty-one days after leaving Southampton; our only stops were at Port Said, for ten hours; at Colombo, where the troops went ashore for a route march, for twenty hours; and at Singapore, for one hour, to put off a sick man. We spent much of our time in speculation as to whether we should ever reach Shanghai, and if we did, what we should do when we got there. I may say that what we had to do exceeded our wildest flights of fancy. We had lectures on China and the Chinese; we read books on China, and we tried to keep pace with the Chinese situation by studying the scanty bulletins. Everyone in the ship was in the frame of mind when they were ready to believe anything, and the entire staff leaped from their bunks early one morning to read the amazing news that Shanghai had been looted, only to find, on reaching the end, that the whole thing was an

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elaborate and skilfully worded hoax. We were wakened in the morning by the stamping of P.T. shoes, we wrote our letters to the accompaniment of rattling machine and Lewis guns, and we were lulled to sleep after tiffin to the strains of at least two schools of "house." To these tortures were added those of the doctors, with their pills, vaccines and inoculations, which were, administered at intervals, calculated to keep us from feeling entirely fit for the whole voyage. In spite of all these horrors we were a very happy ship, and the time passed pleasantly enough.

Arrived at Hong Kong, we were greeted with the news that McCandlish and Wilson were to help the harassed R.E. Staff there, while Major Witts and I were to proceed by the first available ship for Shanghai. The feelings of all concerned are perhaps better left to the imagination. After four days of maddening delay at Hong Kong, we changed into the *Karmala*, and went up to Shanghai with half the Armoured Car Company, those of the Staff who had not been kept at Hong Kong, and a portion of the H.Q. personnel.

We tied up at the quayside on a cold, wet afternoon, on the 8th of March, and started to unload stores at once, to the accompaniment of the "Ah—Ha, Oh—Ho" of the coolies. That evening and the next day were spent in getting the troops into quarters, and my first job was to go off and inspect the billets destined for the H.Q. personnel.

I will now try to give an impression of Shanghai from the billeting point of view. The city (by which I mean the International Concession) stretches for some ten miles along the North bank of the River Whang Poo, and is about three miles deep on an average. The river is half-a-mile wide, very swift-running, and presents the most cosmopolitan selection of shipping. In connection with this, a knotty problem arose when the Ensign was hoisted on the flagship, H.M.S. *Hawkins*. It is the custom to play the National Anthem, followed by those of all other nations in port, in order of seniority of their commanders. In this case there were no less than eight, and it was decided to cut short the entertainment and play one a day in rotation.

The settlement itself is a network of streets, of which the main thoroughfares are wide and well kept, and on to which face the large business houses and the better-class residences. The spaces between these main arteries are filled with a maze of narrow, evil-smelling, filthy alley-ways, and a jumble of ramshackle houses. Towards the outskirts of the settlement is the residential area, which stretches beyond the settlement boundary westward for five miles along the municipal roads. What available open spaces there are in the settlement are unsuitable for tents, being low-lying and under water in wet weather, filling and drainage being necessary before any building can be undertaken. The sanitary arrangements, except in the most modern houses, are of a primitive nature, and the Chinese ideas of hygiene not conducive to taking advantage of what amenities

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are available. These disadvantages are almost set off by the excellence of the municipal water and electric supplies.

Into this over-crowded city were poured 16,000 British troops alone in the space of two months, from the middle of February to the middle of April. All these had to be adequately housed, with sanitary and cooking arrangements to combat the hot weather and its attendant ills. The former was supposed to begin at the end of May, but fortune favoured us in this year of topsy-turvy seasons by postponing it till the last week in June. Owing to the unceasing efforts of the doctors, the latter did not take such a heavy toll as had been anticipated up to the end of July, when I left for home.

Colonel James, Dykes, and two foremen of works arrived on the 26th February with the first instalment of the Staff, to find the Public Works Department, and the Billeting Committee, under Colonel Logan, hard at work taking up buildings and erecting huts, in a gallant endeavour to meet the coming influx of troops. Their help was gratefully accepted, as we were without knowledge of available properties, and their advice, without which we should have been in sorry straits, was of inestimable value.

To detail the arrangements for the billeting of the troops is a task better left to the official pen, and it is enough to say here that they were quartered in mat-shed huts with wood floors, unlined wooden huts, cold, cheerless "godowns," stables, and dirty Chinese houses. The weather was cold and wet; being in a city, it was not possible in the majority of cases to make even field sanitary arrangements; the troops in the line were soaked daily, and were not able to dry their clothes; there was nowhere for them to play games, except the Race Course, which was miles away from any unit not actually billeted there; they had every discomfort imaginable; all of which would have been far easier to bear had there been any chance of a fight. The orders were that no shot was to be fired save in extremity. Add to these drawbacks every opportunity and encouragement from outside to get into trouble, and you have some idea of the strain put on the moral fibre of Thomas Atkins. All these things were patiently endured and steadily bettered; but the first two months of war under peace conditions (or *vice versa*) was a period which stretched the tempers of everyone very nearly to their limit.

Force H.Q. were at Ewo Terrace, where the C.R.E., S.O.R.E., and two A.E.'s worked in one room, with one telephone, and our massive staff of two clerks and a draughtsman in a room downstairs with no means of communication; a defect which was speedily remedied. We had brought twelve motor-cycles with us, and, being Triumphs, they lived up to their reputation by being our trusty companions during the whole of the early period. We were later promoted to cars, when the danger to the life and limb of scarce and hence valuable

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members of the R.E. staff had been amply demonstrated by a number of smashes of varying intensity.

A word as to the Chinese traffic mentality may help to illustrate the dangers of riding and driving in Shanghai. All the motor-cars in China live in Shanghai, and are driven by Chinese, whose one idea is that if the horn is screaming they are safe. The speed of the traffic would scare the most daring thruster at home, and the control is in the hands of Chinese and Sikhs, who, to give them their due, are remarkably efficient; but they are powerless to control the pedestrian whose main idea is to cut as close as possible to the front of a rapidly-moving vehicle, in order that the devil, who is in constant attendance, may be caught unawares, run over, killed, and so disposed of for the day. A Chinese on a bicycle never steers a straight course, for that would make it far too easy for the pursuing devil. In addition to these, there are the usual dangers of wet and slippery streets, tram lines, and that perpetual menace to motoring—the man who will never make the correct signal.

Our immediate problem was to set to work and make the troops as comfortable as possible for the moment. We procured excellent maps from the Intelligence Staff, and on them marked the unit H.Q. Armed with these and a notebook and pencil, we set off on motor-bikes to explore the town.

Our normal day's work was somewhat as follows:—

8.30 a.m. to 9.15 a.m. Telephone.

9.15 a.m. to 1 p.m. A hectic rush from point to point on a motor-bike, instructing contractors, haggling over prices, telling them to "do it again," going into unit orderly rooms, and being seized upon by the Adjutant, the Quartermaster, the Medical Officer, and all the company commanders in turn; these all badgered us for everything, from "We simply must have another light in here, my clerks cannot see a word at night," to "When are you going to build a new kitchen, dining-room, bath-house, and canteen." We wrote everything politely in our little black books, with a pious expression of hope that they would all be put in hand at once, and then went off to try and make some order of priority which was apt to be lost sight of by the people concerned. Then came tiffin, after which we were again a mixture of commercial traveller, foreman of works, bargain-driver, fairy godmother and newsagent—it was firmly believed that the entire staff confided to us all their dispositions; at least, that was the impression that we got from the numerous and baffling questions that were hurled at us wherever we went. Tea and business could usually be combined with someone who wanted something.

8 p.m. Dinner, and a short respite, after which we sat down to study our little black books, which had become quite a by-word From them we wrote out orders on contractors, made out schemes, struck out the unessential (making a mental note of something not

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too rude to tell the mutt who had asked for the moon) and arranged our next day's programme.

It may be asked at this point why we did all these things ourselves; the answer is that we had two clerks, who had all they could do to keep pace with the C.R.E.'s correspondence, and five foremen of works, who had just completed their course at Chatham, and were fully occupied in trying to keep pace with the work in hand. At this period, the settlement was divided into two halves by the Soochow Creek, Dykes being A.E. East, and I, A.E. West.

During the first six weeks, the 10th H.Q., Madras Sappers and Miners, were hard at work helping to make the line more tenable and comfortable. The problem of wiring the settlement was complicated by the fact that the Chinese houses on the boundary roads all had a back entrance on to the Chinese city of Chapei. There was much wailing from shopkeepers in the centre of a long stretch of wire that their trade was being taken away from them by those more favourably situated. Posts were built at points all along the line, and eventually assumed the most complicated designs. At one place they constructed a concrete pill-box which came to be known as the tower of Babel, because it was built by Madras S. and M., under British supervision, for the Japanese; the traffic was controlled by Sikhs, and the crowd kept on the move by Chinese Police.

The S. and M. had the unenviable task of issuing R.E. stores and materials; for weeks afterwards they were chasing picks, shovels, and tools, to which units innocently swore ignorance. Later, when the defences had been completed, they turned their attention to the construction of movable concrete and steel pill-boxes; they also carried out the first experiments in hut raising; as a grand finale, six huts were carried in sections down Broadway during the heaviest traffic of the day.

The state of emergency was declared on the 21st March, and we all donned revolvers and tin hats, which were an added burden to us on our motor-bikes. The following day, McCandlish, Wilson, and two more foremen of works arrived on board the *Bellerophon*. The former took on the job of A.E. West 1, while I gracefully retired to the position of A.E. West 2; the latter went to help Dykes as A.E. East 2. He was later installed in an office by himself, under the title of A.E. Central, and worked the central district and the Pootung side. That was done in anticipation of two more subalterns, who were reputed to have sailed from England. The sites of most of the new camps were necessarily towards the outskirts of the settlement, and therefore fell to the lot of either A.E. East or West. As their work became heavier, so A.E. Central expanded, and relieved them of their more central billets.

Temporary accommodation having been completed, we took a deep breath and plunged into the problem of permanent accommoda-

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tion on a scale to suit the doctors; mat-sheds and forty men in a 70 ft. by 20 ft. hut, with the hot weather and flies only six weeks away, put them in a terrible state of agitation. Followed a period of house hunting by the Billeting Committee, frequent shuffling of units by the Staff, and feverish planning of camps and alterations to buildings by ourselves.

We had now reached the stage where it was possible to apply the principles of plan, specification, estimate, and contract, as the need for economy overcame the necessity for speed. The P.W.D. gave us their list of contractors and their schedule of prices, found us some Chinese draughtsmen, and we started to get tenders for everything that was not required by the next day. Their schedule was of some assistance in giving us an idea of prices, which were all over the place. As an example of this, I will quote my experience with iron hooks for equipment. I called for tenders, and duly accepted the lowest for fifteen Tael cents apiece, a price which was considered high but not absolutely unreasonable. After about six weeks, Dykes called again, as the first supply had run out, and he got the same thing for six Tael cents; it took a long time to live that down. We tried later to get contractors to accept the Hong Kong schedule for all kinds of work with a fixed variation, but they said that prices were fluctuating too much to allow them to take the risk. Everything had, therefore, to be done by tender, and, later, we began to build up an abbreviated form of schedule by making running contracts for all kinds of repair and maintenance work.

A word as to the Chinese contractor, his estimating, morals, organization, and honour, may give some idea of a few more of our problems. The contractor with whom one deals is probably a financier, who sublets a large order to a number of smaller jobbing contractors. He is, of course, responsible that the work is satisfactorily carried out, and to that end we always stipulated that his "No. 1 Man" on the job should be able to speak English. He was rather shy at coming forward at first, but when he saw that we meant to pay he rushed to share in the spoils.

We had some trouble with upstarts at the beginning, but we soon got to know them, and settled down to the best men.

His estimating is on the hit-or-miss principle, and bills of quantities are unknown even on the largest works. In our case, we had some astonishingly diverse answers to our calls for estimates, as they all had to be returned in the shortest time possible, and it was very often difficult for a ring to be formed. Sometimes a surprisingly low price could be obtained by asking for an estimate "while you wait," but our usual method was to take the lowest price, and then haggle with the contractor.

The Chinese are born gamblers, and are always ready to toss for it: so that, if one's idea of a price did not agree with the con-

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tractor's, a reduction could frequently be effected by an appeal to this sporting instinct.

Once a price has been fixed, there is no getting out of it, even if the contractor has missed a point in the agreement, as he frequently did. Often he would turn up unexpectedly in the evening, to try and get the lowest price for a certain job, or bring presents for no apparent reason; in the latter case, one would look for something going wrong the next day, and one was very rarely disappointed. He could never grasp our reasons for refusing his presents and invitations to dinner, and regarded us as quite mad for not taking what to them is legitimate *cumshaw*. He does not try to get away with large evasions, but tries a number of small ones to achieve the same effect. These gave us endless trouble by having to get things done again.

The "chink" is good in the matter of organizing his work; all the hutted camps were built on the mass-production principle, and, once he had got the hang of anything, he turned it out at the most amazing speed. Materials arrived in the right order and in plenty of time to keep the job moving, and I never saw work held up for want of men or materials, save in the case of mud filling (of which more anon). The only factor which seriously held up the work was the rain. "Belly wet day, no man can come." This led to much argument as to the number of rain days, when deciding the date of final completion of any work.

They are gifted with a very considerable sense of humour, and solemnly assured us that there was plenty "cry-cry in the tea shops," as we were so strict in enforcing our conditions as to the quality of materials used. There is an old story of a foreigner, who thought that he was getting the better of a Chinese, who had got the contract to build a new kitchen for him. He told his Chinese tutor of his deal, and the latter said, "You think you make plenty cheap job to pay Wong $200. I tell you he sublet to Kong for $100, and he sublet to Fong for $10, and he make 100% profit."

One in particular was a most cheery rascal, who had been producing very poor timber for some time, so that we had had to take vigorous measures. He came to me one day and said, "Sir, perhaps more better I fix timber tempolally, then suppose you say it no belong ploper fashion, I take it away. Bye and bye I build myself a new house and use the wood you no like."

This return to orthodox methods produced its crop of paper, and we were soon up to our ears in estimates, specifications, contracts and bills. About this time, also, the unit orderly rooms had begun to get busy, and the clerks to get regular exercise, which flooded us with a mass of correspondence, the chief subject of which was:—

"The following points were noted by the M.O. on his inspection on the —th. May they please receive immediate attention."

These we treated in a somewhat cavalier manner, sending them back

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with a pencilled reply on the bottom. The result, of course, was that when a reminder arrived, which was always the case if the job had not been completed within 48 hours, starting " With reference to my ———, dated ———," we had nothing filed for reference, and so the reminder was sent back with " This matter is in hand " written on the bottom. This reply was nearly always true, as we kept all these small jobs written in our little black books, and worked them off as quickly as possible. When we eventually did get a clerk, on 30th May, it took us some time to get out of bad habits, and write proper replies.

All this rapid ordering of work produced its corresponding flood of bills, which had to be checked and paid ; we got to the stage when we simply dreamed of bills. We managed to educate the contractors to sending their bills in in duplicate, which saved the clerks much time and trouble, but we could never get them to realize the time it took to effect a final payment. Most firms have a *compradore*, who handles the cash, and when a contractor sends in a bill he receives a *compradore* order for 75%, which he cashes straight away. Our machinery for checking and signing was quite beyond his comprehension, and up to the time I left I think he still believed it was some subtle method for avoiding payment, and regarded it with the deepest suspicion.

The Chinese Dragon Boat Festival fell on the 4th of June, just as this flood of bills was at its height ; this, and the Chinese New Year, are the two great settling days, with the result that we were besieged by contractors all clamouring for payment, and the combination nearly drove us crazy.

I must break away here to say a word about the King's Birthday Parade and the Torchlight Tattoo, both of which were held on the Race Course, where there was plenty of space, and excellent accommodation for the spectators. The 2nd Battalion of the Coldstream Guards performed the ceremony of the Trooping of the Colour in a manner which fully upheld their high reputation. After this came a march past by detachments from every British unit in Shanghai, including the Shanghai Scottish and the Sikh Police. The whole performance was very impressive, and served to give a good impression of the large number of British troops in the settlement.

The Torchlight Tattoo was exceedingly well staged, and did much to raise British prestige in Shanghai. The majority of the spectators had never seen anything of the kind before, and the applause with which it was received, both in the stands and the local Press, was ample testimony to the feeling that it evoked. The Americans were particularly appreciative of the marching and counter-marching of the massed bands at each function. One was overheard to remark, " Say, if our boys started in on that dope it would take the whole of the New York police a week to get them sorted."

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The types of work with which we had to cope were varied; they included barrack accommodation, hospitals, ordnance depots, aerodromes, mechanical workshops, and bakeries. These all had to be fitted into huts, or ready-made buildings, whose designers had no more idea of them being turned into anything else than flying over the moon. In many cases, the buildings were old and dilapidated, and had been condemned to be pulled down. In every case we had to alter and amplify the cooking, sanitary and lighting arrangements; in the crowded part we were reduced in several cases to building kitchens, and in one notable case, a bath-house and battery of flush latrines on the roof.

The aerodromes were magnificent mat-sheds, 70 feet by 80 feet by 17 feet high to the eaves, about whose construction we had serious doubts. These were fully justified when one of them collapsed, after a ditch for laying fire hydrant pipes had been dug, while our backs were turned, exposing the feet of all the side struts, which play a very large part in the stability of these structures. Fortunately, owing to the vigilance and intelligence of the foreman on the job, there were no machines in it at the time, and no further accidents occurred, though it was the subject of a very good leg-pull on the A.E. concerned!

In nearly every case the sites taken for camps had to be raised, and our transactions in mud assumed immense proportions. These operations were very hard to keep checked, as all mud and ash coolies are trained (or appear to be) in the art of juggling mud from a measured heap to one about to be measured. Contractors would never take the measurement of the hole and give a price for doing the job, but always insisted on measuring the mud at the side, and then throwing it in, a procedure which gave us endless trouble. They also hollowed the tops of the heaps, and dug little trenches round the bottoms; the haggling and arguing that ensued nearly turned our hair grey. In two cases, huts were built on ponds that we had drained and filled, and we had pile-driving operations, which were very amusing to watch. They consisted in erecting a staging on which a gang of coolies stood in a circle; each coolie had a rope attached to the collar of a 225-pound monkey, which they heaved up and down to a chanty rather reminiscent of the Volga Boatmen.

The permanent wooden huts were built on concrete footings, raising all timbers from the ground; they were made with vertical T and G boarding on studding, and lined with wall boarding of various sorts—we bought all there was in Shanghai, and sent abroad for more; they were ventilated by means of louvres along the roof and over the windows, and were fitted with fans and electric light. A large consignment of wall-board went astray, and did not arrive till after the hot weather had begun, and so we were reduced to expedients for lining. In one case, we used Chinese plaster, which

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was put on at a great speed, and made a very nice-looking job when it was done. In another case, we used three-ply ash, in great fear and trepidation, fully expecting it to disintegrate at the end of the hot weather.

All the timber was very unseasoned, and the shrinkage that took place on a dry day was enormous, and we had great difficulty in inducing contractors to produce even the best that was to be obtained. The local civilians said that we were too rigid in expecting exact compliance to our standards, but we persisted in our "armed" inspections, and in the end got better material than we had thought possible at the beginning. Our "arms" consisted of a stout chopper, with which we destroyed undesirable timber, a proceeding which was very good for discipline, as well as the quality of the timber.

The drainage of the sites was rather a problem, owing to the difficulty of getting a good fall. We only attempted to cater for the steady rain, as, when it really made up its mind to rain, all the creeks and main drains backed up, and everything was flooded for some hours, till the waters had subsided.

Hot-water schemes, electric light, and cooking arrangements had, of course, to be thought out in every case, and in connection with the latter a rather amusing situation arose. We had discovered a very satisfactory and cheap type of kitchen range, made in various sizes, exactly suited to our needs, which we installed in a number of billets. One of the A.E.'s thought that this firm was getting too much of the benefit of our patronage, and hunted about for another type equally suited to our requirements; he eventually found one, and proceeded to install it in some new billets, only to find, after they had been installed, that they were manufactured at the same foundry as the previous one.

All these serious problems were eventually solved, and everyone was made fairly comfortable. Our existence, though strenuous, was relieved by such merry interludes as turning out the Municipal Fire Brigade to reeve the G.O.C.'s flagstaff halyard, which had come unreeved during a gale. I was at my wit's end for a scheme avoiding the use of climbing irons, or taking the pole down, and there were no ladders long enough, when some bright spark suggested the Fire Brigade, and the ceremony was performed with much speed and dispatch before a large and interested crowd, who had collected expecting to see a grand conflagration.

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WORKS DIRECTORATE.

A Lecture delivered by LIEUT.-COLONEL D. K. EDGAR, D.S.O., *at the Staff College, Quetta.*

I HAVE been asked to speak upon the organization and working of the Works Directorate on the Lines of Communication, and will try to make my remarks applicable to any country beyond the Frontiers of India, illustrated by episodes which came under my personal observation in Mesopotamia.

Before beginning, the scope of the work to be undertaken in a barren country should be realized, as for purposes of engineering all the countries beyond India are barren, inasmuch as the majority of material and personnel for engineering works has to be imported.

According to *Field Service Regulations*, the Director of Works is responsible for the provision, construction and maintenance of buildings, offices, stores, camping grounds, roads, etc., provision of water supply, gas, electric lighting, or other technical plant required for military purposes on the Lines of Communication, and not provided by other Services. The last sentence is open to a very wide interpretation, and means that the Works Directorate must be prepared to tackle any job, which other Services will not undertake.

In order to carry out these many duties, the Directorate should be divided into the following sections :—(*a*) Electrical and Mechanical. (*b*) Engineer Stores. (*c*) Roads and Buildings.

If the road construction represents a heavy item, it might be well to place it in a separate section. Each of these sections would be under an Assistant Director or Deputy Director of Works, and the work of all of them co-ordinated by the Director.

In order that the Director may arrange for sufficient materials and personnel to carry out the works entrusted to him, it is essential that he should be fully acquainted with the general idea of the campaign, know the number of troops and hospitals, etc., for whom accommodation has to be provided, the class or standard of construction to be maintained, and the places at which the accommodation will be required. Very often the latter point will be decided by engineering requirements, such as an available water supply, suitable sites for building and ease of communication, more than on tactical requirements. It is better for the Staff to decide on the District in which it is desired to locate a Cantonment, leaving the recommendations for the actual site to be made by the Engineers.

One point that should be borne in mind when laying out canton-

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ments is the necessity to allow for expansion; and this is especially important for store areas. The areas allotted for stores should be generous in the first instance, and should be capable of expansion in one or two directions. Cramped storage space makes the handling of stores difficult, increases the danger from fire, and makes the work of checking and accounting for stores much more arduous.

Any change of policy should be communicated as early as possible to the Director of Works, in order that provision may be made for additional requirements. One of the first duties of the Director is to draw up War Establishments for the various sections of his Directorate, and these should be capable of rapid extension, if necessary, to meet the needs of the Force. In Mesopotamia, during 1916 and 1917, this expansion was so rapid that in some instances before sanction had been received to a Revised War Establishment, it had been necessary to revise it again, the delay in sanctioning being due to the fact that it had to be submitted to Army Headquarters, India.

The programme of construction would have suffered considerably owing to this delay, if the D.A.G. 3rd Echelon had not acted on the assumption that the Revised War Establishment would be sanctioned, and demanded reinforcements on the new scale in anticipation.

War Establishment for Works should also be capable of small adjustments without revision. For instance, in the E. and M. Section during the period of erection of plant a different class of workmen will be required, from when the machinery is erected and running. This difficulty was overcome in Mesopotamia by entering the majority of skilled workmen on the War Establishment for the E. and M. Section under the one general category of artificers. This allowed the A.D.W. E and M. to vary his trade categories in his monthly demand for reinforcements to meet his ever-changing requirements, without revising his War Establishment.

For the Engineer Field Parks, three distinct classes of personnel have to be provided. (*a*) Store Clerks. (*b*) Coolies for handling stores. (*c*) *Chowkidars*.

The latter item has to be included if it is desired to relieve troops of the duties of guarding stores. Some means of protection for stores has to be devised, and in many cases *chowkidars* are quite as efficient as troops. Coolies for handling stores could be provided from Porter Corps, but this has disadvantages, unless a Corps or portion of a Corps is placed permanently at the disposal of the A.D.W. Parks, and not changed. The reason for this is obvious, if it is realized that engineer stores usually arrive in bulky, heavy and awkward packages, which it requires special training to handle expeditiously. There is a great difference between handling a bale of *bhoosa* and the fly-wheel of an engine, or between a case of condensed milk and a rolled steel joist.

Great difficulty was experienced in Mesopotamia at times on this account. Local Arabs were lazy and inefficient, the average weight

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of stores moved by them was ¼-ton per day. In 1916, the congestion was so bad that General Stokes-Roberts, Director of Works, arranged with an Indian Labour Contractor to bring out 250 stevedores from Karachi on a year's contract. This method of securing labour was only resorted to when other legitimate means failed, and Government of India orders came that it was not to be repeated. However, for a year the handling of stores went on smoothly at the Base Park, Basra. At the end of the year, a part of a Labour Corps was placed at the disposal of the A.D.W. Park, and, commencing at ½-ton per day per man, the average weight of stores handled eventually reached 1¼ tons per day, due to training and organization. On the departure of this Corps, the average dropped, until the new Corps became trained in their duties, which took about three months.

While on the subject of Labour Corps, I may mention that many controversies raged round them on the matter of their administration, control and responsibility. When the first two or three Labour Corps arrived in Mesopotamia, they were Engineer Corps officered by R.E. officers, and containing a large number of skilled artisans. It was possible to give the O.C. charge of a definite area and all engineering works were carried out by him. Later on, when the number of the Corps increased, it was not possible to provide sufficient technical officers, and the Labour Corps became less skilled. The usual procedure became to make a Works Officer responsible for the work, with a Labour Corps to carry out his instructions. The administration of a large number of Labour Corps became very onerous, and a Labour Directorate was formed for the administration of all Labour and Porter Corps, and also the control of local labour. This resulted in economy with regard to the administration and distribution of labour, but when the Director of Labour also wanted to take the responsibility for all works carried out by his Corps, including Engineering Works, there was a difference of opinion.

The Director of Works is the responsible head for works entrusted to him, and the chain of responsibility must run through the officers under him, and cannot be delegated to another Directorate.

The large amount of technical labour required in the " Roads and Building " Section of the Works Directorate was supplied by Works companies. The strength of these companies was roughly 1,000 men, and for the most part consisted of skilled artisans, with a Headquarter Section for administration. The O.C. was in some cases a Technical Officer, but as his whole time, and that of his Adjutant, was spent in administrative work, technical engineering knowledge was not essential, the personnel being detailed as required to the Works Officers in charge of actual works. There were a good many jobs in the Works Directorate which could be run by non-technical officers, in connection with personnel and stores, and this should be borne in mind if there is a shortage of Technical Officers. In Mesopotamia we had

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a clergyman, who had joined the I.A.R.O., a law student, and many others, who did good work on special jobs.

The question of the supply of tools is an important one, second only to the supply of material, as men cannot be employed without tools.

The reserve of tools should be ample, as unfortunately on service the wastage is great, but this wastage can be reduced if the O.C's. Works Companies and Labour Corps maintain tools and plants ledgers for their units.

Take a Labour Corps, for instance; they may be employed on hutting or road-making, or preparing a defensive position in the rear of the army, or other works. Different tools will be required for each job, and it would not be economical for a Corps to maintain all tools which it may possibly require on every occasion. Each Corps should have on its own ledger sufficient tools to enable it to look after itself, and prepare its own encampments and temporary hutting; and they should be allowed to make themselves as comfortable as circumstances permit, for ill-fed and ill-housed men cannot do a fair day's work, and greater efficiency will result if a proportion of the men are detailed for camp work, until everything is ship-shape. The balance of tools for the work in hand should be drawn from the nearest source of supply, and kept on a separate loan ledger. On completion of the work, surplus tools should be returned to store, to be utilized again by other Corps if necessary.

One Corps in Mesopotamia, while at work at the Base, was issued with a circular saw. On being ordered up river for some irrigation work, the O.C. tried to take this saw with him, as he thought it might be useful to him again some day. This was the non-co-operative spirit, but fortunately his designs were discovered, and the power saw and many other useful tools were removed from his possession, and he departed only with the essential tools for the work he was about to undertake. The spirit of co-operation in many cases is noticeable by its absence. Some units go on the principle of everyone for himself, and the devil take the hindermost. They usually manage to make themselves most comfortable by purloining material, etc., and building themselves luxuries, while the more essential services suffer. The R.E. officer alone cannot prevent this, and it requires the assistance of the Staff. There is a great difference between some units, who assist the R.E. in their works and do things for themselves, and others, who obtain unauthorized things by subterfuge. One unit in an outlying part of Basra, on being ordered to Bagdad, proceeded to dismantle their huts and pack the material on a barge, with the intention of re-erecting them at Bagdad. This was not discovered until after they had left, and it took several days to get the barge back and the material unloaded, after which the huts had to be re-erected for another unit. I might add that the delinquent was an R.E. unit.

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Some officers have the knack of getting more work out of men than others; this is partly due to tact, but I think that the proper organization of working parties has more to do with it. If every man does a full day's work, it is extraordinary what can be accomplished by 1,000 men. Where possible, each man or gang of men should be given a set task, and allowed to return to camp on completion of it. The tasks can gradually be increased as men become accustomed to the work. Owing to the fact that men are engaged on a monthly rate of pay, it is difficult to pay them by piece work, but this can be overcome by offering a bonus or overtime for extra work beyond their set tasks.

If men are slack and lazy, some punishment must be devised to fit the crime, and this is where a good O.C. proves his value. A combination of a deterrent to slackness and an inducement to work produces the best result. It is not always possible to give men set tasks, but with a little ingenuity some species of task work can usually be devised. Men who are doing hard manual labour require rest days. One day in seven is sufficient, but whether the whole Corps should be rested for one day a week or 15% of the men allowed off every day depends on circumstances. The men enjoy the rest better if all are together, and it also gives an opportunity to the officers and supervising staff to rest if the whole work is stopped for a day, but the stoppage of the work may interfere with other Departments, in which case it will be necessary to lay off a proportion of men each day, and allow the work to carry on continuously.

Reinforcements for technical personnel is a difficult matter, and received a great deal of attention in India, especially during the latter part of the War, when labour was becoming scarce. The early organization in India was not capable of dealing efficiently with the great demand for labour which took place in 1916. Men arrived at Basra without nominal rolls or identity discs, and it was impossible to say for whom they were intended, and after arrival a great deal of work was thrown on the O.C. unit, to which they were eventually attached, in the preparation of their papers. I remember one instance of the arrival of 150 Chinese carpenters, who were booked as Chinese carpenters for the Works Directorate, but were not in possession of any of the necessary papers. The O.C. Works Company tried to prepare the nominal roll, showing next-of-kin, and to issue identity discs; but as many of the men possessed the same name, and all gave as their next-of-kin their uncle Foo Sing, who was the agent who engaged them, it was difficult to identify them. In addition to this, they appeared to attach a monetary value to their identity discs, and would gamble with them, and after a lucky night one man might be in possession of several discs, none being his own. After several weeks, the O.C. Works Company produced some sort of order out of

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chaos, but I am certain that many Chinamen who died were reported under wrong names.

Before reinforcements are dispatched from India to the Base, each party should be in possession of several copies of a nominal roll, showing their number, name, next of kin, trade category, depot in India, and for whom intended ; a copy also being sent by post to the Directorate concerned, showing date of dispatch, and name of ship. With regard to the identification number, each Directorate should have a distinguishing letter prefixed to the number. For instance, carpenters were required for the Works Directorate, Ordnance, I.W.T., M.T., Railways, and others. The letters W.D., O., I.W.T., M.T., etc., were placed before their number, and there was no possibility of the men being posted to the wrong Directorate. If, during their term of service, they were transferred from one Directorate to another, they were allotted new numbers, and the change published in Part II orders, copies of which were sent to all concerned in India. In order to avoid duplication of numbers, it was arranged with India that a certain block of numbers, say from W.D. 5,000 to W.D. 10,000, should be reserved for use in Mesopotamia, and not allocated by depots in India.

At the Base, a depot should be formed to receive the reinforcements, and distribute them to their Directorates. In case any Directorate is large enough to warrant a separate depot, this should be formed under the Director concerned. In Mesopotamia, all the large Directorates had their own depots for the arrival and dispatch of personnel, those for miscellaneous units going to a central Followers' depot.

A great many complaints were registered in Mesopotamia regarding the class of artisans sent out. It is most difficult for the recruiting officer to know whether a man is a fitter, as he claims to be, or only a fitter coolie. A system of trade tests is the only means, as a rule, for ascertaining a man's capability, and even this then is open to abuse by impersonation. However, special cases can be dealt with by special means. Towards the end of 1916, when a large electric installation of 750 kw. had to be erected in Basra before the hot weather of 1917, and it was necessary to obtain a large number of skilled and efficient personnel for the work, permission was obtained to send an officer from Mesopotamia on recruiting duty in India, who knew where the labour could be obtained, and who picked his men personally. The results were eminently satisfactory.

The personnel sent on service should be the best possible available ; they should be dispatched expeditiously, and once they have left their depot should be got on to their work in the least possible time. These men have to be paid and fed whether they are working or not, and unnecessary delay causes loss to the State. On arrival at the Base Depot, if all papers are in order, 24 hours should be sufficient

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to check, muster, issue tools and extra clothing if necessary, and to dispatch on to the works.

To enable the dispatch of reinforcements to be carried out expeditiously and efficiently, there must be a sound organization from the recruiting depot to the Base depot; any weak link when delays occur will cause loss to the State and inconvenience to those expecting the reinforcements.

With regard to the rates of pay of this civilian labour, unless some control is exercised, Directorates will vie with each other to obtain the best labour, and offer better and better terms, causing enormous rises in the price of labour. It is for the recruiting authorities to decide the minimum rates of pay at which labour can be obtained, and a schedule of wages should be laid down. In preparing this schedule, it should be recognized that all men of the same trade are not of equal value to the State, as there are many grades of workmanship. To overcome this difficulty, each trade category should be divided into grades 1st, 2nd and 3rd, if necessary, with a sliding scale of wages. If there is a large number of recruiting centres, it is most unlikely that the grading of men will be equitable, and, when on service, this will cause dissatisfaction where superior men are working alongside of inferior ones, and the latter drawing more pay. For this reason, Directors should be empowered to promote men from one grade to another, or from one category to a higher one; instance, a 1st-grade carpenter might be promoted to be a 2nd-grade carpenter *mistry*. This will also give men an incentive to work well, if they know there is a chance of promotion. Similarly, bad workmen should be reduced in grade. Under the agreement in force in Mesopotamia, this was a difficult matter to carry out, and a clause should be entered in the agreement empowering the Director to make such reductions.

In Mesopotamia, it was found that the only way to reduce a man was to give him the option of accepting a lower rate of pay or being returned to India as incapable. When the expense of recruiting and transportation is considered, it is most undesirable to return men to India after a few weeks' service, but it is equally undesirable to have incompetent men drawing high rates of pay. Clauses should be embodied in this agreement regarding the scale of clothing, rations, period of engagement, concessions, such as leave and free travelling, and also the rates of pay drawn while in India or on leave, which should be less than the rates on service. With regard to the period of engagement, such indefinite terms as " Duration of the War " should be omitted, and the term of engagement should be for a definite period on service, irrespective of the time spent in depots in India. The hours of work, overtime pay, etc., should be governed by rates of the Directorate in which the men are employed.

It is equally important to have an efficient organization for the purchase and dispatch of stores. The consignee should be informed

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as early as possible of articles dispatched, date of dispatch, name of ship or number of the railway wagon containing the articles. In the Mesopotamia campaign, up to the end of 1916, an officer, designated the Engineer Stores Officer, was responsible for the purchase and dispatch of all Engineering Stores, but unfortunately it was not realized what work this duty entailed if it was to be carried out efficiently, and, in addition to his duties as Engineer Stores Officer, he was also A.C.R.E. Bombay, and officiating C.R.E. of the Poona Division. It was impossible for any one man to carry out all these duties, and consequently, until the Munitions Board was organized, this branch of administration left much to be desired.

In those days, it was a pleasure to receive stores from England, as full information was given in the form of packing notes or bills of lading, giving the contents of each package, the marking thereon, so that it would be easily recognized, the particular hold in the ship in which it was carried, and a reference to the original order under which it was consigned. Such information is invaluable, especially in the case of machinery, when the whole plant can be checked without laboriously opening every case and sorting out the parts.

I may cite an instance of how things ought not to be done. The need for ice-making plants in Mesopotamia was early recognized, but because the S. and T. are responsible for the distribution of ice, that Department was deputed in India to purchase the necessary plant. The Director of Works was not informed of what was being done, and the first information received was a notification from a Medical Officer that six ice plants were arriving, consigned to him (the M.O.) by name. A Works Officer was detailed to collect these plants, and eventually about 100 packages, said to contain parts of these ice plants, were found on five different vessels. This was in 1916, and the result was that by the end of 1918 it had been possible to erect two out of the six ice plants dispatched. The balance were incomplete, and being second-hand, and purchased by an inexperienced officer, were not worth the time and labour necessary to erect them.

The purchase of second-hand plant is unfortunately necessary for a big campaign, but the greatest care should be exercised in dismantling and packing, to ensure that everything is complete, and lists made of what each package contains. When purchasing new machinery, this is done by the firm selling the articles, but it is often overlooked when taking over second-hand plant. An experienced mechanical engineer should be detailed for this duty.

If any complaint is received with regard to the suitability of either stores or personnel, fullest consideration should be given to the matter, as the man on the spot knows his requirements, and is responsible.

The marking of packages so that they may be easily recognized is also important, and in addition to the numbers and letters usually

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found on all packages, a distinctive coloured band should be painted on every article (except food and forage, etc., which cannot be mistaken), to indicate for which department it is intended. For instance, a red and blue band for Works, yellow for Ordnance, green for another Department, etc. This proved to be a great convenience in Mesopotamia, and resulted in a great saving of time in sorting out a mixed cargo.

If this procedure had been adopted in the return of stores from Duzdap to Quetta, I personally should have been saved a lot of worry in trying to trace stores which had been returned to Ordnance instead of to the Engineer Field Park, and a sounder organization at Duzdap would probably have saved the loss of some lacs worth of stores of all kinds.

I have dwelt rather fully on the organization behind the Lines of Communication, but I consider it a most important point to free the Director of Works and others from the worry entailed in receiving stores and personnel sent in a haphazard manner.

The relation between the Staff and the Director of Works is laid down in *Field Service Regulations*, Chap. III, Section 22, paras. 2 and 3. This requires daily personal intercourse between the Director's Office and the Staff, therefore the two offices should be situated close to one another if possible. Whether the Director should have his Headquarters with the I.G.C. or at G.H.Q. depends on circumstances. In Mesopotamia, the Director of Works remained at Basra until G.H.Q. was established at Bagdad, when his headquarters moved there, and he was then represented at Basra by a Deputy Director of Works, Lines of Communication.

The area between Basra and Bagdad for the Roads and Buildings Section was divided into districts, each under an A.D.W., who had at his disposal sufficient works officers and a works company, or a portion of one, to carry out his duties. Sufficient unskilled labour was placed at his disposal by the Labour Directorate under orders from the Administration Commandant. The charges of these A.D.W.s varied from time to time to meet requirements, but, to give an idea of the organization, I will take a period when there were 2 A.D.W.s at Basra, one at Kurna, one at Amara, one at Kut, and two at Bagdad. At that time, there were more than 200 officers employed in the Works Directorate, and it was found that the Director's office could not exercise direct control over such a large number of A.D.W.s, in addition to the E. and M. Section and the E.F.P.s ; so two Deputy Directors of Works, Roads and Building Section, were appointed, one at the Base and one at Bagdad, from whom the A.D.W.s received instructions.

The head of the E. and M. Section was a Deputy Director, and under him were two Assistant Directors, one at Basra and one at Bagdad, the dividing line of their charges being between Kut and

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Amara. At every station, E. and M. officers were in charge of plant, who for technical purposes were under the A.D.W. E. and M. concerned, but in other matters were administratively under the A.D.W. Roads and Buildings or Senior Works Officer at the station, who dealt direct with the Administration Commandant, as representative of the Director of Works.

The Engineer Stores were under the A.D.W. Park, with his headquarters at Basra, and an Advanced Park at Bagdad to supply the needs of the field army, as well as local demands. At one time, there were intermediate Parks at Kurna, Amara and Kut, but eventually these were dispensed with, and the stores transferred or taken over by the Works Officers as a Works Dump.

There should be one large Park at the Base to hold the reserve stock, and Advanced Parks at railheads or other convenient points to supply the field forces, and also Parks at points on the Lines of Communication wherever these lines bifurcate. Intermediate Parks should be reduced to a minimum, as they absorb more personnel than their use warrants.

The organization of the Works Directorate as outlined above grew up in Mesopotamia as a result of trial and error, but with modifications should meet requirements in any campaign beyond the frontiers. All three sections of the Works Directorate have separate functions, but their duties require to be co-ordinated by one head. In splitting the sections into various sub-divisions, it was found that, when the number of sub-divisions exceeded five, it was necessary to re-arrange the charges, and place one responsible head over three or four subdivisions. The channel of control can be compared to an irrigation system spreading over a large area of country. The headworks are the Director's office, from which the whole system is controlled, and the amount of water passed through represents the work. No one branch should feed more than five subsidiary channels, otherwise the distribution becomes difficult, and that branch fails. The analogy is not quite correct, as by mechanical means the capacity of any branch may be increased almost indefinitely, but the brain of the human being is not a machine, and the limit of its capacity is fixed, except in a few cases of supermen.

I fear I have in some instances departed from my subject, but all I have said is applicable to the organization and working of the Works Directorate on the Lines of Communication, and all has been gleaned from my experiences with the Works Directorate in Mesopotamia.

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THE ZHOB VALLEY RAILWAY SURVEY.

By BRIG.-GEN. H. H. AUSTIN, C.B., C.M.G., D.S.O.

IN a previous article* attention was drawn to a proposed extension of the railway beyond Peshawur, *via* the Kabul River, in order to facilitate the maintenance of a force operating in Afghanistan along the line of the historical highway leading through the Khyber Pass. The scene now shifts to Baluchistan.

With the object of bringing Peshawur into more direct communication with Quetta, on the south-west flank of the exposed frontier, General Sir James Browne desired a detailed examination to be made of the country lying between Dera Ismail Khan on the Indus—some 200 miles down-stream of Attock—and Quetta. The distance apart of these two frontier stations by the route sought through the Zhob Valley was roughly 350 miles; and a great saving in distance and time would be effected if Quetta could be thus linked up with a line (since constructed) running along the East, or left, bank of the Indus from Attock to Mari, and south towards Sukkur.

The Zhob district is situated in the north-east corner of Baluchistan, and has an area of close on 10,000 square miles. The country is for the greater part mountainous, but the southern side is traversed by the Zhob Valley, and the northern by the valley of the Kundar, which later joins the Gomal. The chief inhabitants of this area are the Kakars, who possessed little military organization at that period, and were badly armed, for the trade in rifles smuggled into Afghanistan from the Persian Gulf had not touched the Zhob. The Kakars had no love for the British, though they tolerated them, since they were powerless to do otherwise. Still, had they an opportunity to give trouble in times of difficulty, they would probably have made good use of it.

In the upper 80 or 90 miles of its course, the Zhob Valley runs generally in an easterly direction, and then swings N.N.E. for about 130 miles before it is joined by the Gomal from the west. Here the territory of the turbulent Waziris is entered.

Now, it was only in December, 1889, that Sir Robert Sandeman, the Agent to the Governor-General in Baluchistan, first proceeded with an escort of cavalry, infantry and guns on a tour through the Zhob Valley. His object was to explore the country of the Mando Khel tribe down to the junction of the Zhob and Gomal Rivers, and to arrange terms with the Waziris for the opening of the Gomal Pass. Sir Robert started from Loralai—a small frontier station,

* (Kabul River Railway Survey.—*R.E.J.*, Sept. 1927.)

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100 miles east of Quetta as the crow flies—on December 19th, and reached Apozai, 100 miles down the Zhob in a N.N.E. direction, on the 26th. Here he remained for some three weeks holding durbars attended by all the leading Zhob *maliks*, and negotiating with *jirgas* of Mahsuds, Zalli Khel, Dautanis and Shiranis. Negotiations completed, Sir Robert continued down the Zhob, leaving a Political Officer at Apozai with an escort of all arms. The junction of the Zhob and Gomal at Kajuri Kach, some 70 miles farther on, was reached by him on January 25th, 1890, and here he crossed the Gwaleri Kotal by the old Powindah caravan route, avoiding the formidable gorge of the Gomal below the junction of the two rivers, and so to Tank on the trans-Indus plain.

"Annexation Bob"—the name by which Sir Robert was sometimes disrespectfully known, owing to his pronounced predilection for acquiring territory for the Crown—thus brought another huge slice of country under British jurisdiction.

It will be realized, therefore, that this fresh railway scheme of Sir James Browne was far more ambitious than the Kabul River one. A great extent of country, little of which was known, had to be closely examined from a railway point of view; and hundreds of miles of alternative alignments would have to be surveyed in order to determine the least expensive route to be followed. Hence the command of the survey operations was entrusted to Major (now Colonel Sir) Buchanan Scott, R.E., an officer of wide railway experience, who had been one of Sir James Browne's Executive Engineers during the construction of the Harnai Railway.

As all field work was to be completed during the cold weather season of 1890–91, Major Scott organized the expedition into five survey divisions, each of which consisted of three R.E.s and two infantry officers, with a subordinate staff similar to that employed by Macdonald on the Kabul River Survey. That survey party complete formed one of the divisions of the new Zhob Valley Survey, and took the field at the Quetta end of the line in September, 1890, with two others. The two remaining divisions commenced work from the Dera Ismail Khan end somewhat later, as the heat in the plains, there less than 600 feet above sea level, was still great.

The Zhob Field Force of 1890, under the command of Major-General Sir George White, then G.O.C. Quetta, and accompanied by Sir Robert Sandeman, was assembling at Khanozai, some 16 miles from Khanai station on the Harnai Railway, at the same time as the survey parties. The military force was destined for the punishment of those sections of the Shirani tribe which had refused to meet Sir Robert at Apozai the previous January, and had for long behaved in a truculent manner. It marched off for the Zhob Valley on October 1st; and the survey divisions commenced work at once from Khanai on the projected railway.

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It is scarcely possible, within reasonable limits, to follow in detail the numerous routes surveyed by five separate, though co-operating, parties during the seven or eight months they were working in the field. Macdonald's division had the good fortune, however, to traverse a very large tract of country between Khanai and the junction of the Zhob and Gomal Rivers; and it was given an opportunity also of seeing something of the stupendous gorge through which the Gomal pierces its way, when joined by the Zhob, to reach the plains of India. Consequently we travelled along the entire length of the proposed railway, save that portion lying on the trans-Indus plains. We saw little then, it is true, of the country between Kajuri Kach and Dera Ismail Khan; but a few years later, during the Waziristan Expedition of 1894–95, I was able to bridge the hiatus when proceeding from Wana to Tank and Dera Ismail Khan by way of Kajuri Kach and the Gomal, over the Gwaleri Kotal.

Khanai, the starting point of the projected Zhob Valley Railway, is three stations down the Harnai Railway from Quetta, and is situated about 5,450 feet above sea-level. The suggested alignment immediately commenced a steady ascent to Khanozai, and up the Sarkhab valley to the summit of the Mehtarzai Kotal, the water-parting between the Sarkhab and Zhob. A rise of over 1,800 feet occurs in this first 35 miles or so of the line, necessitating a serpentine course in the latter half to gain distance for a ruling gradient of 1 in 100, when surmounting the steeper slopes of the valley.

Although it was still only the end of October when we reached the Mehtarzai Kotal (7,260 feet), the cold at nights in our camp near its summit was severe. Basins of water in our tents were found frozen solid every morning; whilst the wind was of a particularly piercing nature. Much relief was experienced, therefore, when the progress of the survey enabled our camps to be moved lower down into the Zhob. The fall from the Mehtarzai was something like 1 in 30 at first, which entailed much zig-zagging during the descent of 1,250 feet to Hindu Bagh, distant about 16 miles from the top of the pass. The country hitherto traversed had been truly typical of Baluchistan: bleak and barren to a degree, with scarce a live shrub or blade of grass at the end of summer to break the monotony of stony uplands devoid of trees, save around the few scattered villages near the foot of the hills. The bare frowning aspect of the rugged heights by which we were beset, though not lacking in grandeur, served but to accentuate the inhospitable character of our surroundings. Striking was the change, therefore, to find at Hindu Bagh a pleasant post established amidst an oasis of trees, and garrisoned by a small force of cavalry and infantry; whilst much arable ground in the vicinity had been brought under cultivation by an abundant supply of water obtained from *karez* channels.

As winter was fast approaching, the three divisions which had been

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surveying various tracts of country in the neighbourhood of Quetta, now received orders to cease work in that area for the present and to march down to Apozai. Thence, the course of the Zhob and Gomal Rivers, and other alternative routes, were to be surveyed during the most severe months; and a return would be made to complete the upper portions of the railway alignment in the spring.

Thus it was with light hearts we set forth for more genial climes, as the high hills around were already capped with snow when we marched from Hindu Bagh on November 22nd. The district road constructed from Khanai ceased at Hindu Bagh, and onwards there existed but a rough path leading down the Zhob for 130 miles to Apozai. In this distance the Zhob falls about 1,500 feet only—from 6,000 to 4,500 feet above sea-level—and as the valley is generally open, and several miles in width, it presents few difficulties from a railway point of view.

Despite some unpleasantly long marches for our slow-moving camel transport, and heavy rain throughout several days, we managed to obtain a good deal of small game shooting during this trek. The perpetual stones of the Quetta plateau gave place in parts to soil of a grey clayey nature, extensively cultivated about villages, the land being irrigated by means of ingeniously derived water-channels.

Shafts are sunk as much as 80 feet deep on sloping ground to reach water. Should water be struck, a succession of shafts, every thirty or forty yards apart, is sunk lower down the slope; and these are connected together at their bottoms by low tunnels. Since the fall of the ground is far steeper than that necessary to ensure a flow of water from one shaft to another, it follows that the depth of each succeeding shaft can be greatly reduced, and the water thus gradually brought close to the surface, when it is run along open channels to irrigate fields over a considerable area of ground.

These *karez* shafts furnished abodes for many blue-rock pigeon, and very pretty shooting could be had by throwing a few clods down them. Their alarmed occupants would then come bustling up with a great beating of wings in the confined space, and as they dashed off on their flight when reaching the open they afforded quick snap-shooting to guns distributed around the shaft. Large flocks of blue-rock were seen, too, circling about the cultivated areas; whilst numerous sand-grouse, chikor, sisi, duck, teal, plover, and hares, kept our stock-pot going throughout the journey down the Zhob.

Few incidents of note disturbed the even tenor of our way. White men were rarely met, though we did camp one night alongside an Irrigation Officer, examining the possibilities of the country under the protection of a small escort. Whilst dining with us, he scoffed at all idea of being molested by the local natives, but soon after our arrival at Apozai he came tumbling in there precipitately. A gang of *budmashes* on the rampage had suddenly appeared in the vicinity

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of Gwal Haidarzai, where we had forgathered, and he considered that was not a healthy spot in which to linger with his few sepoys.

The most conspicuous landmark in that part of the Zhob is a huge pyramidal rock, Smakhwal by name, which rises abruptly to a height of 450 feet from the plain-like valley, some 20 miles short of Apozai. Viewed from our previous camping-ground it seemed but a few miles distant. Yet after a weary tramp of 20 miles we had only come abreast of it, and our stage was still 3½ miles beyond at Badanzai. Our camels were nearly twelve hours on the road, and it was dark long before camp was pitched; so, being on rear-guard duty that day, I have good cause to remember the elusive form of Smakhwal as we crawled towards it the live long day.

A further march of 16 miles, however, landed us at Apozai, now known as Fort Sandeman, on December 2nd, and here we found ourselves again in a small frontier station recently established. Only six months before had a start been made on the sun-dried brick huts and buildings which accommodated, at the time of our arrival, an Indian Pioneer battalion, two squadrons of Indian cavalry, and two guns of an Indian Mountain Battery. The Political Officer's palatial stone residence was built on one of several small eminences within the limits of the little cantonment, and was occupied by Lieutenant (now Colonel Sir Henry) MacMahon, then a most energetic young frontier officer and destined to be a future Agent to the Governor-General in Baluchistan.

Apozai, though a veritable outpost of Empire in those days, was in telegraphic communication with Loralai, and with one or two lesser posts farther down the Zhob, such as Mir Ali Khel. The country round was still in a very unsettled state, however, and officers were not permitted to go out riding except in pairs, and armed with revolvers. Thefts of camels, and other transport animals, by tribesmen were frequent, and fanatical outbreaks common. A few days before our advent, a gang of coolies, employed on road-making ten miles down the Zhob, were cut up by a band of *ghazis*; while several of our camels were stolen, together with those belonging to other divisions, during our short halt at Apozai.

The morning our division marched for Gul Kach, on the Gomal River, a great uproar occurred in the cavalry lines as we were passing it. A Mando Khel, seemingly strolling unconcernedly by, suddenly turned *ghaza*, and drawing his sword rushed at a sowar of the 12th Cavalry, whose head he nearly severed with a blow on the back of his neck. Before anyone could check him, the *ghazi* slashed another sowar across the arm, and a third over the hand. The other sowars, then realizing what was afoot, made a dash at the fanatic with drawn swords and quickly cut him to pieces. His mangled remains were then burnt as a deterrent to such other natives as might desire to emulate his example; and Paradise thus denied him.

In anticipation of trouble in the lower reaches of the Zhob and

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Gomal, our Pathan *khalassies* had all been armed, some with rifles and others with swords, whilst engaged on the survey about the Mehtarzai Kotal. We had drilled and trained them in the use of their weapons; and our camps were pitched in perimeter fashion with tent ropes overlapping, their defence by night being tested by occasional surprise alarms. We had started from Khanai with an escort of twelve Bombay sepoys under a havildar, but they proved so incompetent and insubordinate that we returned them to their battalion at Peshin early in November, and continued without them. Now that we had reached more disturbed regions, however, escorts of a more efficient nature were provided for the survey parties.

A few days were spent in preliminary surveys about Apozai, in the hilly tract some 13 miles to the west of the station, and beyond the Zhob River which was still fordable. We then returned to accompany the 3rd Baluchis and a squadron of the 12th Cavalry to Gul Kach. This column was joined by MacMahon as Political Officer, and was commanded by a noted frontier soldier, Colonel Nicholson, the husband of "Laurence Hope." A personal escort of 50 men of the Baluchis, under an Indian officer, was furnished for our survey division; but the whole force marched together through some 50 miles of very difficult and broken country, the abode of many bad characters, that intervenes between Apozai and the Gomal River.

Here, at Gul Kach, our environment was wild in the extreme. The summits of the higher hills around were already white with snow; and our camp on the right bank of the river, towards the eastern limit of the Domandi plain, overlooked its broad stony bed down which five or six fordable channels were flowing. The opposite bank, and the country beyond to the north, was then temporarily recognized as the territory of the Amir of Afghanistan; but was later allotted to India in accordance with the terms of the Durand Treaty. Near by, to our right, lay the entrance to the gorge of the Gomal, which extends almost without a break for 25 miles before joining the Zhob at Kajuri Kach.

A short distance above the gorge, and on the left bank, one's gaze was arrested by a confused mass of clay cliffs and mounds beneath which, if local legend is to be believed, are buried the ruins of Sodom. The Almighty had, it is said, become so wrath at the evil doings of its inhabitants that He had plucked the city up by the roots and hurled it back into position upside down. Hence this turmoil of sand and clay, reputed to be haunted by *jin*, or spirits, to this day. A horseman and two women are said to be seen at certain seasons wandering disconsolately among the ruins, but they did not cross our path; while, at a later date, the so-called ruins of Sodom were pointed out to me on the banks of the Tigris, not far down-stream of Kut. Some rivalry seems to exist, therefore, between Pathan and Arab for the possession of the site of this notorious town.

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The Baluchis and cavalry went into permanent camp at Gul Kach as a covering force for the various survey divisions working in the neighbourhood. One division under Captain (now Colonel Sir John) Pringle, R.E., was to survey down the Zhob from Apozai to Kajuri Kach; another, under Captain (now Brig.-General) G. S. McD. Elliot, R.E., between Apozai and Gul Kach; and ours between Gul Kach and Kajuri Kach. The other two divisions, under Captain (now Major-General) C. H. Cowie, R.E., and Captain (now Major-General Sir John) Capper, R.E., were at work between Dera Ismail Khan and the exit of the Gomal into the plains of India, and in the Gomal gorge itself below its junction with the Zhob.

At Gul Kach we were about 3,000 feet above sea-level, a fall of some 1,500 feet between Apozai and that place; but in the first 17 miles out of Apozai, by the route our division had marched, the ground rises nearly 500 feet to the Nawa Oba Kotal. A descent of close on 2,000 feet over very intricate country in the last 35 or 40 miles to Gul Kach would, therefore, be entailed in obtaining a railway alignment to that point. Subsequent observations showed that the fall of the Gomal between Gul Kach and Kajuri Kach is less than 900 feet in a distance of 26 miles; so the question of gradient is comparatively simple. But the character of the country between the two places would make the construction of a railway almost prohibitive in cost.

Indeed, we estimated in the field that the cost of this 26 miles of railway would amount to a sum not very far short of that for the entire Kabul River Railway of 55 miles between Peshawur and Dakka. The Gomal would probably require to be crossed three times by large bridges between Gul Kach and Kajuri Kach; and no less than twenty-four tunnels, with a total length of about 3¾ miles, would also be necessary in this section.

In any event, between Apozai and Kajuri Kach, the more direct route adhering to the 70-mile course of the Zhob was shown to be a much less costly proposition. But even here, owing to the confined nature of the sinuous valley, enclosed to a great extent by lofty hills and broken slopes, the construction of a railway would involve very heavy work, though a steady easy gradient is procurable.

We were the first Europeans to penetrate the gorge of the Gomal between Gul Kach and Kajuri Kach; so I propose entering into somewhat more detail of our experiences whilst surveying in it. The route between Apozai and Kajuri Kach by the Zhob was already pretty well known, for a frontier road was in course of construction down it, and posts had been established at certain stages along it.

Soon after our arrival at Gul Kach, Macdonald deputed me to lay out a road down the gorge if possible, with a view to enabling us to work towards Kajuri Kach along it. I was thus the first white man to enter it; but, after following the gorge for a couple of miles, it became clear that a large amount of labour, and much

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time, would be involved in making a camel track through, owing to the slender means at our disposal and the precipitous nature of the narrow rocky defile the river had carved out as its course. The idea had to be abandoned, therefore, and it was decided that the division should march to Kajuri Kach, and work up-stream to Gul Kach instead.

Since the gorge route was impracticable for heavily-laden camels, MacMahon supplied us with a dozen Sulaiman Khels, who were to conduct us into Amir's territory across the river, over the Kandori Kotal and thence into the Gomal again, close to where the Toi River, flowing from the Wana plain, joined it on the left bank. Fording the Gomal at Gul Kach, our nervous guides led us some three miles north along the foot of sand cliffs, and then turned east up a large nullah rising near the Kandori Pass, a spot of evil repute as the haunt of marauding Waziris. The ascent of 700 feet from the Gomal was comparatively easy, though the pass is shut in by high cliffs; and whilst seated on the summit, enjoying a light lunch, we discerned the forms of men standing out against the sky-line, 1,500 to 2,000 feet above, but they made no attempt to molest us. The descent on the far side, on the other hand, was very difficult for our camels, the track being rocky, rough and broken for the first two miles. We then entered a narrow valley down which eight or ten parallel tracks ran side by side, for we were now on the Powindah highway by which Ghilzais and other traders travel between Ghazni in Afghanistan and India.

This valley gradually decreased in width until it became little more than the low cliffs of a large nullah, down the bed of which the tracks continued to another nullah that took us to the Gomal, a short distance above its junction with the Toi. The Gomal was again forded and camp pitched on a small stony plot of high ground, known as Toi Khula, which overlooked the stream.

By this detour of some 15 miles in the Amir's territory we had circumvented twelve to thirteen miles of the sinuous Gomal gorge impracticable for camels, and were now half-way to Kajuri Kach. Next day, however, was Christmas Day, so we remained halted and spent a thoroughly miserable Christmas. At dawn the rain was pattering, not unpleasantly, on our tents—quite reminiscent of home. But when a furious gale sprang up in addition, seasonable sensations evaporated, for our tents were with difficulty restrained by their pegs and ropes from embarking on aerial flights, and we anxious occupants were chiefly engaged in clutching on to camp tables, chairs and other articles, lest these should be transported bodily into the river below. As the hurricane of wind blew direct from the snow-clad hills without, it was truly arctic in its bitterness, and intensified our discomfort.

Our well-planned Christmas dinner, too, proved something of a frost, since the turkey, plum pudding and champagne we had ordered

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from Lahore, to do honour to the festive occasion, had become stranded at Dera Ismail Khan, and thus failed to reach us in time. When the turkey did eventually arrive in its air-tight tin, weeks later, it was accorded a decent burial, as we quickly discovered there was no other use to which it could then be profitably put.

The gale continued throughout the night, and only died away in the early morning. It was horribly cold and freezing hard when we set out on the march of twelve miles to Kajuri Kach; and the river had to be forded a number of times—a cheerless procedure as the water was waist deep, and rapids frequent. This portion of the gorge was practicable, however, for transport animals by crossing at intervals from one bank to the other, in order to take advantage of such narrow strips of gently sloping ground as existed between the foot of the cliffs and the river.

Camp was pitched on the right bank of the Gomal at its junction with the Zhob, which entered from the S.S.W. The beds of both streams here opened out to an astonishing extent, that of the Zhob being 500 to 600 yards wide, and the Gomal close on 400. As in times of flood both rivers completely cover their beds, a magnificent spectacle is then presented by their boisterous meeting. A defensible post occupied by Zhob Levies was situated on the right bank of the Zhob, on high ground overlooking the junction. It was supposed to afford security and protection to all and sundry travelling by, or camped under the shadow of its walls; but the experience of the Sulaiman Khels, related in *Waziri Ways*, shows that it scarcely fulfilled its function.

We were now in touch with one of the survey divisions at work on the Dera Ismail Khan end of the line, under the command of Captain Capper. He was camped some 5½ miles down the Gomal below its junction with the Zhob, and was faced by the most difficult problem of the whole Zhob Valley line, that through "Browne's Gorge." Capper cordially invited us to visit him, that we might see something of this really remarkable freak of Nature; and pleased we were to take the opportunity of doing so.

Crossing the broad bed of the Zhob just below the Levy Post, we proceeded down-stream to find ourselves soon confronted by a narrow opening between magnificent precipices towering hundreds of feet above us. Here we had to leave the river bed, and followed a branch nullah on the left bank which led to a rough pathway, cut by Capper, in the slopes of the hills. Continuing over broken ground, amid numerous fantastic pinnacles and ridges, we descended by a zig-zag track to the bed of the Gomal again; and at once passed through a gap between two gigantic boulders, one of which was 60 feet in height, and as many yards in circumference. It went by the name of "Adam's Kark," for that early man is credited, in local lore, with having pasted his dough round this modest stone before baking it in a fire for his bread. Near by was another large

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curious-shaped rock, with a great hollow scooped out of it, which was known as "Adam's Chilamchi," or basin, because he washed his hands in it prior to partaking of food. A turn to the left, a short way on, brought us to Capper's camp, perched on a small plot of ground on the left bank of the river, 15 to 20 feet above the water level, and closed in on all sides by stupendous precipices.

Later, we rode farther down the river bed, crossing and recrossing the stream which was then 30 to 40 yards wide, three feet deep at the fords, and flowing swiftly in a series of short rapids. A mile below Capper's camp the river made an extraordinary bend of nearly a complete circle of small radius before entering the famous "Browne's Gorge"—thus named after General Sir James Browne, the first European to view it. We had to dismount at the mouth of the gorge, and proceeded on foot by a rough path then being constructed by Capper's Waziri coolies along the face of the cliffs.

The scenery here well-nigh baffles description. Immense precipices of hard limestone rock rise aloft nearly 1,000 feet, and almost sheer on both sides of the chasm. Nowhere does this exceed a width of 30 to 40 feet at its base, and the cañon twists and turns bewilderingly, while the combined waters of Zhob and Gomal surge furiously down the narrow winding cleft for a distance of three-quarters of a mile. The cliffs then begin to open out again gradually to 30 or 40 yards; but in times of flood so tremendous is the struggle by the impounded waters to force their passage through this puny aperture that they become banked up to a height of 60 feet above the normal cold-weather level. It will readily be understood, therefore, that much tunnelling would have to be resorted to, in order to overcome Nature in this awe-inspiring rift in the mountains.

The Gomal remains confined to a winding gorge of noble proportions for some 25 miles below Kajuri Kach before it enters the plains at Murtaza, distant about 18 miles from Tank. In the 50 or 60 miles between Murtaza and Dera Ismail Khan, the railway would traverse open, though broken, plains presenting no special engineering difficulties. A considerable amount of cultivation exists thereabouts, for the irrigation of which the waters of the Gomal are practically all absorbed and little usually reaches the Indus.

After this instructive and most interesting glimpse of Capper's problems, Macdonald's division commenced working up the Gomal towards Gul Kach from Kajuri Kach; and a few Dautanis were attached to our survey party in place of the Sulaiman Khels, who returned to their homes in fear and trembling lest they should encounter Waziris *en route*. The Dautanis were supposed to be at peace with Sulaimans and Waziris alike; and their presence in our camp was intended to serve as some safeguard against outside interference by the Waziris, on whose border we now were. Nevertheless, as our work progressed slowly up the gorge, and camp moved at intervals farther and farther up the Gomal, thefts and alarms

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became almost a nightly occurrence at one time. Though one could not entirely withhold admiration for the cool audacity of these Waziri thieves, their activities sorely interfered with our nights' rests after hard days of toil in the field.

As I have already attempted, however, to give readers of the *R.E. Journal* some idea of our experiences then in " Waziri Ways," I need not stress the subject further here. It will be sufficient to state, therefore, that the survey from Kajuri Kach to Gul Kach was much hampered also by the vile weather, which frequently prevented out-door work being done. What with rain, furious gales, snow, hard frosts, a swollen river, and difficulties of terrain to contend with, it was February 16th before our work joined up at Gul Kach with that of Elliott's division, which had been surveying to that spot from Apozai. A few days later, we marched by a new route across the Girdao plain to Mir Ali Khel, about mid-way between Apozai and Kajuri Kach along the Zhob.

Here a strong post had been built, and was garrisoned by 150 men of the 2nd Sikhs and half a squadron of the 3rd Punjab Cavalry from Dera Ismail Khan. Notwithstanding their presence, this locality possessed an unsavoury reputation for lawlessness Outrages were of frequent occurrence up and down the frontier road under construction, and night alarms were an almost everyday affair. Consequently, Lieutenant Vesey, the officer then in command of the post, led a stirring life, and had many a grisly, sometimes humorous, story to unfold during the several occasions we were encamped outside the stalwart walls of his fort. Even there we did not escape nocturnal molestation from gangs of blackguards who infested the wild neighbourhood.

The next month was employed on branch surveys between Mir Ali Khel and Gul Kach; and we spent the best part of a week, too, about the Kandori Pass, whither we returned in order to examine an alternative line, avoiding the upper half of the Gomal gorge near Gul Kach.

Shortly before, when working in the Siri Toi near Mir Ali Khel, one of our *khalassies* foolishly strayed from the line of march, and was, presumably, murdered immediately by some *budmashes*. In any case his body presented a horrible spectacle when ultimately recovered by a search party, sent out after dark with lanterns on his absence from camp being reported. Nothing was ever seen, of course, of his assailants, though the broken country was scoured far and wide for them next morning.

We were back at Mir Ali Khel for the last time on March 20th; and the following day commenced the return journey to Apozai by the Zhob Valley route, bound for resumption of survey work on the upper sections of the line between Apozai and Hindu Bagh. A fine frontier road along the right bank of the valley made the march of 36 miles, in three stages, a very simple affair. But the road by no means adhered entirely to the course of the river, which, confined

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between close-set heights, indulges in some perplexing contortions in this area. Nevertheless, it was abundantly clear to us that the Zhob between Apozai and Kajuri Kach presents far less difficulties than the Gomal alternative between the same two places.

Divers traders, and other natives, attached themselves to our column with their laden camels and mules during our march from Mir Ali Khel, as the lawlessness then rife in this district caused them to seek protection under our wing. Even so, we met one poor way-farer who had just been set upon by Waziri *budmashes* in a turn of the road on ahead. He had been robbed of all he possessed and badly slashed as well in three places by their keen swords. Macdonald and Gloster, with the advanced guard, started off with a few sepoys in pursuit of the ruffians, but saw no trace of them. One seldom did; yet they were always lurking amid the hills on the look-out for whom they might devour.

Pringle's division, which had earlier surveyed the Peshin section of the upper alternatives, and had recently completed that from Apozai down to Kajuri Kach by the Zhob route, now began to work up from Apozai towards Hindu Bagh; while Macdonald's division marched up the Zhob to the vicinity of Hindu Bagh, and worked down the valley to meet Pringle. This survey progressed at so rapid a rate that by April 19th the gap of 130 miles had been bridged by the two divisions, and the railway alignment clearly marked out on the ground between those two places.

The next fortnight was employed, however, in making further improvements in the original alignment on both sides of the Mehtarzai Kotal. Thus it was May 5th before our work in the field was finished, and we were free to return to Quetta.

During our five months' absence from this area of the Zhob, the appearance of the country had undergone a remarkable change. In the autumn all was bleak, dried-up and drab, but in the meantime the seemingly sterile stony soil had been quickened by winter sleet and snow. Now, in the spring, one's eyes were refreshed with a sense of colour. The former all-pervading, sun-scorched camel thorn, had burst forth into green young leaves, creating an air of life and cheerfulness. And, strangest of all, out of the unpromising earth bulbs and flowers had forced their way, and were in full bloom. The ground was gay with red and yellow tulips, poppies, hyacinth-like blossoms, purple bells, diminutive pansies, and other species of wild flowers which almost brought beauty into our surroundings.

Nor were we the only ones to appreciate the altered conditions of Nature, for myriads of locusts now assembled—as in the Kabul River at the same season the previous year—to take toll of the green refreshment supplied. On several occasions whilst at work, the sun was completely obscured for an hour or more by dense clouds of countless locusts overhead. The ground, too, was thick with them, and they were gathered up in sacksful by the Kakars, who dry their

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bodies and grind them into flour. Traffic up the Harnai Railway was even impeded by hosts of these insects, for their crushed bodies so lubricated the rails that locomotives and carriages had some difficulty in surmounting the stiff gradients in places.

The three remaining divisions had meanwhile been carrying out various important alternative surveys in the uplands; and at the close of the season's work, Major Scott could congratulate himself on the fact that a most thorough examination of every possible route between Quetta and Dera Ismail Khan had been made. The personal energy of Major Scott throughout the work in the field had been inspiring to all. He was ever on the move from one division to another, spending a few days in this camp, and then in that; so that he might see for himself the difficulties of terrain, and advise how best to overcome them.

He was frequently accompanied by Mrs. Scott, who defied every form of hardship and danger, so enthusiastic was she to learn all about the country, and the multifarious problems that confronted her husband in the great task committed to his charge.

The Scotts and the R.E. officers of all five divisions later assembled at Dalhousie, where, in the summer months of 1891, comprehensive reports, plans and estimates were prepared on the information gained during their combined labours in the field.

Since those days the railway from Quetta has been extended in a north-westerly direction to the Afghan frontier at Chaman, by piercing the Khojak Pass with a tunnel 2¾ miles in length. In a westerly direction it had reached Nushki before the Great War, and during the War the line was carried still farther over the sandy wastes towards Sistan. But no attempt has yet been made to connect Quetta by a broad-gauge railway with Dera Ismail Khan, *via* the Zhob and Gomal. This, though shown to be perfectly feasible, is presumably due to the decline of the Russian menace; and to the costly nature of the undertaking, as disclosed by the investigations of the Zhob Valley Railway Survey parties thirty-seven years ago.

Nevertheless, a two-foot gauge line was built from Khanai to Hindu Bagh some years ago, in order to convey valuable chrome deposits thence to the main railway system; and this light line is now being extended down the Zhob. It has already (June, 1927) reached Kila Saifulla, some 40 miles beyond Hindu Bagh, and I understand is likely to be carried on the remaining 90 miles to Fort Sandeman. The large increase of the garrison at that cantonment in recent years has added much to the difficulties of maintaining this force in so advanced a position without the aid of a light railway.

It may well happen, therefore, that, in the years to come, some young R.E. officers of to-day will be called upon to construct, in its entirety, the Zhob Valley Railway line surveyed by Major Buchanan Scott and his colleagues in 1890-91.

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THE PRESENT POSITION AS REGARDS MECHANIZATION.

By BT. LIEUT.-COLONEL G. LE Q. MARTEL, D.S.O., M.C., R.E., M.I.MECH.E.

IT is so attractive to write and read about the eventual future of mechanization, that the present position is seldom described as clearly as other subjects which lend themselves less to future forecasts. That we need some policy to guide us, as the ultimate aim in mechanization, is obvious, even though we know that our forecasts will be as inaccurate as any other prophecies, but the whole subject is so beset with difficulties at this stage, that the present position and immediate future need constant study and constant change in immediate policy in order to achieve our objects with the least possible delay.

From the moment that mechanical warfare was introduced in 1916, there arose a demand for mechanical assistance of this nature in many directions. In addition to tanks, track vehicles were ordered for supplies and ammunition, for the transport of artillery, for engineer work, and for many other duties, and the whole subject was grouped rather loosely under the term "mechanical warfare." This resulted in a somewhat confused state of thought, and in order to make a logical division between the various ways in which we can obtain assistance from these vehicles, the subject may be divided into three branches—strategical, tactical and administrative mechanization.

Strategical mechanization is used to move troops and reserves from one part of the battlefield to another with great rapidity, *e.g.*, if the necessary vehicles are available a complete division can be moved 100 miles in 24 hours, and if the vehicles are of a cross-country type the move can be carried out across country, where the enemy has endeavoured to impede progress by the use of extensive demolitions. Having arrived at their destination, the troops may or may not be assisted by armoured vehicles, but the object of strategical mechanization is a rapid movement over a long distance.

Tactical mechanization is used to enable troops to fight on the move and behind armour on the battlefield, *e.g.*, the tank, the armoured car, and the gun on a self-propelled mounting.

Administrative mechanization is quite another matter. It is used mainly to assist the administrative services. First of all, there is expense under peace conditions; properly organized mechanical

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transport is far cheaper than the equivalent in horse transport. Secondly, there is the question of the transportation of forage or petrol to maintain the transport of an army in the field, and very great savings can be effected in both bulk and weight when mechanical transport is substituted for horse transport. This is particularly important in an overseas war, when the available sea transport is limited. Lastly, there is the question of the difficulty of maintaining the fighting troops when they have advanced across country where extensive demolitions have been carried out, or when they are a long way from railhead. Under these conditions, cross-country mechanical transport can often compete with requirements which could not be met in any way by horse-drawn transport.

In strategical mechanization we are now in a position to make good headway. For a long time we floundered with track and semi-track vehicles, until the R.A.S.C. came to our rescue with the six-wheel lorry. A start has already been made in mechanizing the first-line transport of infantry battalions with these vehicles, and there is every chance of their commercial use, which may ease the mobilization difficulties, and pave the way for a considerable extension in mechanizing first-line transport. This will overcome the main difficulty of strategical mechanization, for, although there has never been any great difficulty in collecting buses and lorries for the rapid movement of dismounted men, the movement of their first-line transport has represented a serious difficulty in the past. With the use of six-wheel lorries the first-line transport can travel with the buses, and the whole unit can cover very long distances at a high speed. There are, of course, some forms of tactical mechanization which bring with them strategical mobility, but the necessity of carrying armour reduces this mobility in a large degree. The Vickers tank, for instance, is far less mobile than a six-wheel lorry under average conditions; the mobility of the armoured car is second to none, but this is achieved by the use of very vulnerable wheels, which reduces to a large extent its tactical value. It is possible that small track vehicles of the Carden Loyd type may combine the advantages of tactical mechanization with strategical mobility, but, generally speaking, these two branches pull against each other, and advantages in one direction, such as the provision of armour, can only be obtained at the expense of the other. The advantage of strategical mechanization is obvious to everyone; it renders no assistance to the infantry-man in a frontal attack on the battlefield, but if a force of one or more infantry divisions can be moved rapidly to the flank or rear of the enemy position, then the battle may be won without the use or necessity of any armoured fighting vehicles at all.

Administrative mechanization is closely wrapped up with the progress that we are making in strategical mechanization. The six-

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wheel lorry brings with it a great saving in financial expenditure, and a large reduction in the shipping tonnage required to maintain an overseas force. Even a wide belt of extensive demolitions has less fear for a force that is well provided with these vehicles. The dragon, like all whole-track machines, is a very inefficient form of transport, but its replacement by the six-wheeler enables us to combine the advantages of administrative and strategical mechanization, particularly if we develop a well-designed type of "artillerie portée," in which case a very high speed on roads can be maintained, combined with low running costs.

It is with tactical mechanization, however, that we enter on to controversial and difficult subjects. Here the six-wheeler is of little value. It is true that six-wheel armoured cars will be useful for long-distance reconnaissance, but their fighting value will be very small. Their mobility is entirely dependent on the pneumatic tyre, which is very vulnerable. It is true that these tyres can be replaced by semi-solid tyres of various types, which are unaffected by bullets, but these tyres reduce the cross-country capacity of the vehicle, and the speed on roads, to a considerable extent. Six-wheelers will, therefore, be limited to armoured reconnaissance, and armoured mounts for officers and staff, and although these duties are important, they represent only a small part of the work of armoured fighting vehicles. The present trend of thought is to divide the use of these vehicles into two branches—the employment of armoured fighting vehicles, to assist normal formations, and the employment of an independent armoured force.

The former is far less controversial, as it has two years of war experience on which to base deductions. That infantry will be assisted by tanks in the attack for many years to come is certain. For mobile warfare the light tanks, which were formerly known as tankettes, may prove to be the most suitable, but as warfare becomes stabilized the tanks require an obstacle-crossing capacity, and it is necessary to use longer and heavier, and less mobile machines. Anti-tank weapons have been developed, to repel the tank attacks, but, so long as we are dealing with limited objectives in fairly stabilized warfare, the anti-tank weapons can be neutralized by artillery fire and smoke. Future progress on either side is likely to balance under these conditions, and tanks of every type are likely to play an essential part in the assault for many years to come. Whether these fighting machines will form part of infantry units, or be organized in separate units, is a detail which will be adjusted as time progresses.

The employment of an independent mechanized force, however, lends itself to controversy in many different directions. At one time, in the distant past, cavalry were all-powerful on the battlefield, and

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infantry were camp-followers and moppers-up, and the hope is expressed that the independent armoured force may re-introduce this superiority of the mounted arms in a modern form. No one supposes that this superiority would last for ever, but if it is to exist for a certain period, we, as a nation, must be first in the field. Moreover, as we depend primarily on a small regular army, the introduction of an independent mechanized force suits our case. Our men are highly paid, and our small regular army costs as much as the large conscript army of a European country. By roughly halving the numbers of men we can save enough money to mechanize the other half, and we can thus obtain an efficient, highly-trained mechanized force with no increase in financial expenditure. With a European country, such as France, the position is quite different. The efficiency of a conscript armoured force is very doubtful, and in any case when the men are practically unpaid, very big reductions have to be made to pay for the mechanical vehicles. France would, therefore, be reduced to a very much smaller army, if she wished to indulge in any large degree of tactical mechanization, and this would be a dangerous experiment with a country which has a land frontier 300 miles long. In order, therefore, to try out these ideas, and obtain some practical data, an armoured force was formed at Tidworth in July, 1927. Just as we were the first to develop and use tanks in the Great War, so we have been the first to take the next step, and develop an armoured force, and with our present start we should be able to maintain our lead ahead of other nations.

Our present force is a quaint collection of various types of vehicle, but it was far better to make a start with vehicles which were available than to wait for more perfect machines, which might then be developed on wrong tactical lines. At present, many of the vehicles are unarmoured, and that they should all be armoured is agreed to by everyone, but the main controversy rests round the tank. The striking force is at present the Tank Battalion, armed with the Vickers tank, and this is both the least mobile and the most expensive unit in the force. This reacts in two ways; first of all, these tanks hamper the mobility of the force, and secondly, as the vehicles are expensive, they cannot be numerous, and as they have to present a concentrated form of attack, they are liable to heavy casualties from anti-tank weapons. There are many things which are uncertain in the near future, but the one point which does appear to be reasonably certain is that the field artillery and the anti-tank weapons, with which the infantry battalions will soon be equipped, will deal heavy casualties to an armoured force which attacks with a limited number of Vickers tanks. If the force is to lose 50% of its tanks in an attack against an infantry division, then the game is not worth the candle. These anti-tank weapons can be neutralized by smoke and artillery fire, but this pre-supposes a set-piece attack, and for this purpose the

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fighting vehicles would be better employed with a modern form of infantry division. To be of any great value, the armoured force must be able to attack a normal formation which is on the move, without any delay, and be capable of carrying through the attack with success and without undue casualties. The first requirement in this direction would appear to be to increase the mobility and reduce the cost of the Vickers tank, so that we can use dispersion and attack with a very large number of tanks. This was foreseen over two years ago, and as a first attempt to solve the problem the Morris-Martel tankette was constructed. This first model had certain faults, and as neither the makers nor the War Department were prepared to develop the machine, little headway was made until the firm of Carden Loyd came to the rescue. These engineers were prepared to devote their whole time to the development of a small cheap tank.

Their first models were unsuccessful, but by July, 1927, they had produced their fourth model, which competed successfully with the first model of the Morris tankette, and their later models showed still further improvement. What form the future light tank will take is uncertain, it may be of the whole-track or half-track type, and it may develop into a larger and more expensive machine than the present light tank. As regards armour, it may not be possible to provide all-round protection against ·303 armour-piercing bullets at normal impact and at close range, but, provided the front of the machine is proof at close range, and the sides and rear at long range, the light tanks should have no difficulty in subduing all opposition from small arm fire, provided they are used in large numbers. It is these large numbers, again, that will provide safety against anti-tank weapons, for the attack of a swarm of these small fighting vehicles, moving at high speed, will have a most demoralizing effect on the defence. It, therefore, appears likely that there will be a period during which the armoured force, based on a large number of small fighting vehicles, backed up by close support artillery equipped with a very light form of armoured self-propelled mounting, will be very powerful, and, perhaps, decisive, on the battlefield. There will, of course, be many difficulties to be faced, such as administrative questions, but these are the lesser problems, and they will certainly be solved.

In conclusion, it would appear that we are quite safe in going ahead with strategical and administrative mechanization; increased mobility and better administration are of unquestionable value. An article by Major B. C. Dening, R.E., which appeared in the December number of *The R.E. Journal*, gave a very practical scheme for the mechanization of first-line transport, which might take us a long way in this direction. Even India, that is always accused of retrogression, is moving fast in strategical and administrative mechanization, based mainly on the six-wheel lorry. It is in tactical mechan-

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ization that it is so difficult to see ahead, and in which we are up against very real difficulties. Portions of our army must be able to fight in mountains, where fighting-machines are of little value, and then there is the Cardwell system, which must change before we can make progress in this direction. We shall, however, learn much about the tactical side of mechanization during the next few years—both as regards the independent armoured force and the assistance which fighting vehicles can give within the normal formations. It may then become necessary to reorganize the army gradually. In the meantime there is much to be studied. In many places abroad, fighting vehicles would be of great value, and would enable reduction in numbers to be effected. In other places, the possession of an all-powerful army for use on the plains, which we can obtain by the use of suitable fighting vehicles, will render the mountain warfare of much less importance. It is possible that the success of the independent armoured force may be such that the greater part of the army will be organized in this way, and that mountain warfare will be carried out by special troops, or even men temporarily dismounted from a mechanized force. In some stations abroad the regular troops may be entirely mechanized, and the defence of bases and communications be relegated to volunteers or local troops. In the case of our expeditionary force, the divisions may be almost entirely mechanized, depending on our allies and, at a later stage, on our territorial troops, to hold defensive sectors, and to guard communications and bases. At the same time, it is possible that anti-tank weapons will develop more rapidly than we anticipate, and that armour will have a short life. In this case we should be limited mainly to strategical and administrative mechanization, and with these we should progress at full speed, because their value is certain, but with tactical mechanization we must go carefully, as we are on less sure ground.

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THE SHANNON HYDRO-ELECTRIC POWER DEVELOPMENT.

By LIEUT. J. V. JENKINS, R.E.

THE following notes, which are in continuation and amplification of the account of the Shannon scheme published in *The R.E. Journal* for June, 1927, were made after three visits to the works during that year, the last being late in November. A rather fuller description of some of the most interesting plant, which was briefly noticed in the previous article, is included.

I. PROGRESS DURING 1927

(*a*). *Headworks.*

The works on the site of the weir, above O'Briensbridge, have now reached a stage at which it is possible to realize without difficulty the transformation of the surrounding country which will take place when the scheme is completed.

The first section of the cofferdam, next the right bank of the Shannon, has been finished, and the steel framework for the second section, that contiguous to the left bank, is being put in position. The central section, it is hoped, will be erected during the summer of 1928, when the water of the river is at its lowest. The problem of dealing with the flow when the water-way has been completely obstructed, but the full width of the weir is not yet available, will thus be made easier. The current through the restricted channel, where the water rushes past the end of the cofferdam, at an estimated speed of 10 ft./secs., impresses the observer with the desirability of waiting for drier weather before diminishing the passage still further.

Meanwhile, the excavation for the foundations of the weir is proceeding inside the first section of the cofferdam, the walls of which are about 6 ft. thick, and are composed of puddled clay, contained within 9 in. by 3 in. timber sheeting. The timber is itself supported by a framework of rolled steel sections, well strutted and anchored to the bed of the river. This construction appears to be perfectly water-tight, but a considerable quantity of water finds its way into the excavation through fissures in the hard red sandstone forming the bed of the river. The extent of this leakage may be estimated from the fact that on one occasion when the supply of power for the pumps, which normally keep down the water, failed during a storm, the whole cofferdam, some 35 yards square and 20 feet deep, filled to the level of the river in three hours. Stand-by pumps, driven by oil-engines, have since been installed to prevent a repetition of this

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occurrence, in the event of a break in the supply of electricity from the temporary power-station at Ardnacrusha. The folly of relying solely for such important work on a supply of power transmitted for eight miles by temporary overhead lines has thus been demonstrated, and considerable expense has been unnecessarily incurred.

As mentioned in the previous article, the weir is to be built of P.C. concrete, and will be anchored to the bed of the river by steel spikes cemented into boreholes. The object of the arrangement is to prevent sliding of the structure downstream bodily, and this constitutes the most noteworthy point in the design.

The intake building will be provided with sluices to regulate the flow of water into the head-canal. It is sited at right angles to the centre line of the canal, and makes a slight angle with the weir. (*See* Fig. 1). Beneath it is the invert which carries the water from the collecting channel into the Shannon below the weir. The channel will intercept the water, which used to flow into the river, before the construction of the embankments for the storage basin, which have now reached an advanced stage. Unlike the culvert for the Blackwater river, of which a photograph has already been published, this invert has vertical sides and a flattened arch roof, which is heavily reinforced, a 4–2–1 mix of P.C. concrete being used throughout the construction. A catch-pit is provided at the upstream end of the invert.

Fig. 1 shows the general arrangement of the headworks, the cofferdam being indicated by dotted lines. The figure is constructed from sketches made on the spot, and must be regarded as diagrammatic.

(*b*). *Head-canal.*

Ground has been broken throughout the length of the head-canal, and a section about two miles long has been almost completed at the power-station end. In the neighbourhood of Cloonlara, however, scarcely any progress has been made, and an enormous mass of earth has still to be excavated. A great effort will have to be made if the contract date for completion, May, 1929, is to be kept. The broken stone lining of the canal has been begun immediately above the power-station site, and some of the concrete facing at the water-line has been completed. A cross-section of the canal has already been published.

(*c*). *Permanent Power-station Site.*

The work on the Power-station building is going forward very rapidly. Photo 1 shows its appearance at the end of November, 1927. Wooden shuttering is employed, and very large plums are used in the more massive parts of the work. Incidentally, these plums are largely relied on to provide a firm key between parts of the work carried out at different times—a practice which would not recommend itself to all engineers.

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The photograph shows the main features of the building, and a close scrutiny reveals the projections to which will be attached the steel pipes taking the water to the turbines. These pipes were erroneously stated to be of reinforced concrete in the previous article, the writer having been misinformed in the matter on his first visit to the works.

The turbine house itself will be built at the bottom of the excavation, indicated in the photograph by the steam shovel at work, in the foreground. The turbine parts are beginning to arrive from the continent, and include some very excellent examples of steel castings.

(*d*). *Reinforced concrete road bridge.*

The road bridge over the head-canal half-a-mile above the power-station has been completed. Photo 3 shows this bridge under construction, with the heavy timber centring still in position.

The bridge, which is of similar design to those to be built for the other roads over the canal, has a very pleasing appearance, and at first sight seems to be of the flattened arch type. Actually, however, the ribs carrying the roadway are not true arches, but curved beams, capable of slight movement in relation to the piers, so as to reduce expansion stresses. The sudden change in the diameter of the piers marks approximately the future level of the water in the canal. The central span is nearly 100 feet, and the width thirty feet.

The most serious trouble experienced during erection was due to bad ground at the northern abutment, which necessitated extensive piling operations before a firm foundation could be secured. The method of supporting the formed portion of the centring on screw-jacks, which can be seen in the photograph in a line on a level with the tops of the piers, is interesting, and must enable a very accurate adjustment to be obtained.

(*e*). *Electrical Transmission Lines.*

Work has begun on the network of high-tension transmission lines, which will in time cover the face of the country, and that connecting Limerick and Dublin is almost completed. A map of Ireland, showing the chief lines and the voltage at which they will be operated, is appended. (*See* Fig. 2).

II. NOTES ON PLANT AND MACHINERY.

(*a*). *Temporary Power-station.*

This station, which was fairly fully described in the first account of the scheme, supplies power to the whole of the works. The plant is said to be very satisfactory in operation, the only serious mechanical trouble experienced being piston seizures; these were finally found to be due to the lubricating oil being kept too long in use, presumably with the idea of effecting a small economy in running costs. The effect of wear in the valve gear is already very noticeable in the

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running of the overhead cam-shaft oil-engines, silence in operation being a thing of the past.

SKETCH MAP OF IRELAND.

Showing Principal Transmission Lines.

FIG. 2.

(*b*). ***Bank-building machines.***

Photo 4 gives a rather more satisfactory view of one of these very interesting machines than that accompanying the first notes on the scheme. The bank-builders have been evolved from the transporters originally used for winning lignite in the brown coal mines of Germany, and this is the first occasion on which they have been employed in the construction of embankments. It being stipulated that the embankments were to be built up in horizontal layers, the original design had to be altered somewhat for Siemens Bau-union, to whose requirements the machines now in use were manufactured by the three firms, Krupp, Luebecker Maschinenbau-Gesellschaft, and Maschinenfabrik Buckau, in collaboration.

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The machine consists essentially of a double-bucket excavator, and two conveyor belts, one movably mounted below the other on a projecting jib. The bucket chains of the excavator, the parts of which are interchangeable with those of the other excavators in use on the works, pick up soil from between the legs of the machine, either direct from the ground or from a dump deposited by railway tip-trucks in a previously excavated trench. The upper conveyor receives the earth from the excavator *via* a hopper, and carries it out along the jib to the lower conveyor, which can be moved bodily up and down the jib, so that the earth falls from it exactly where required. It will be noticed that the slope and reach of the jib have been selected to suit the embankments to be constructed. The motive power is electricity, and the speed and precision of operation truly remarkable.

The bank-builders are mounted on railway trucks, which have to be shifted periodically as the work proceeds. Three lines of track are required, two for the machine itself, and one for the spoil trains; for convenience of shifting they are all laid on the same sleepers.

(*c*). *Arbens-Kammerer Track-shifting machine.*

This exceedingly ingenious device is used for moving the railway track sideways when necessary, and replaces a gang of fifty men with hand-spikes formerly employed for this work.

The machine, the appearance of which is shown in Photo 5, consists of a girder structure supported at its ends on four-wheel bogies. Mid-way between the bogies is an arrangement of flanged rollers, which, by means of a simple screw and lever mechanism, can be made to grip the top flanges of the rails. The track between the ends of the machine can then be lifted from the ground by raising the rollers, and forced any desired distance sideways up to about one foot, the motion being obtained by screws. If the track-shifter is now coupled up to a locomotive and drawn along the rails, the whole track is raised as the machine passes, and is thrust sideways by the rollers. When the track comes to the ground again under the rear bodies, it has been moved sideways by an amount depending upon the lateral displacement of the rollers. Photo 6 shows the apparatus in operation.

The only apparent objection to the method is the repeated lateral bending of the track, which must cause rapid deterioration, especially when flat-bottomed rails are used.

(*d*). *Stone-crushing plant.*

The stone-crushing plant at Ardnacrusha, briefly described in the previous notes, is now in full operation, and a similar plant has been erected near Cloonlara, on the line of the head-canal. The plant at Ardnacrusha, which is electrically driven, is supplied with the waste water from the jackets of the engines in the temporary power-station for washing the stone. The lay-out is compact and convenient, and the product very clean and well graded.

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THE SHANNON HYDRO-ELECTRIC POWER DEVELOPMENT.

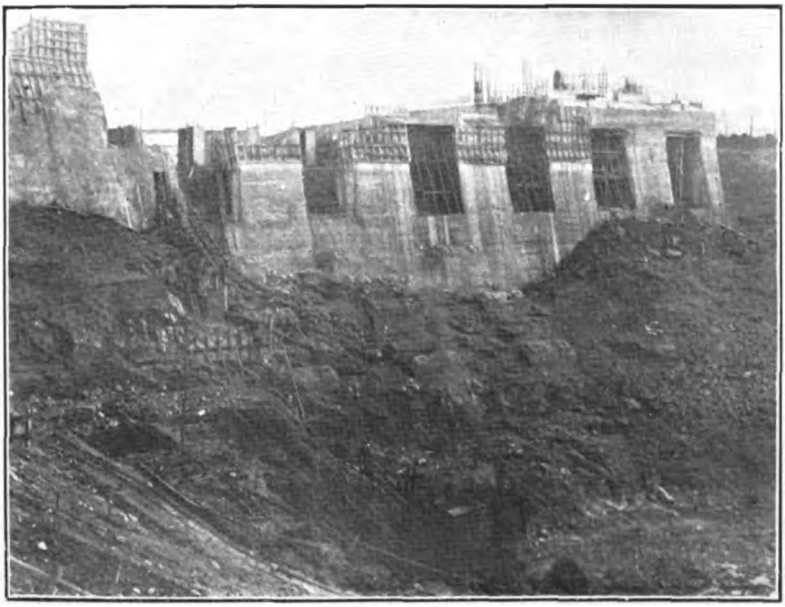

Photo 1.—The Power Station Building.

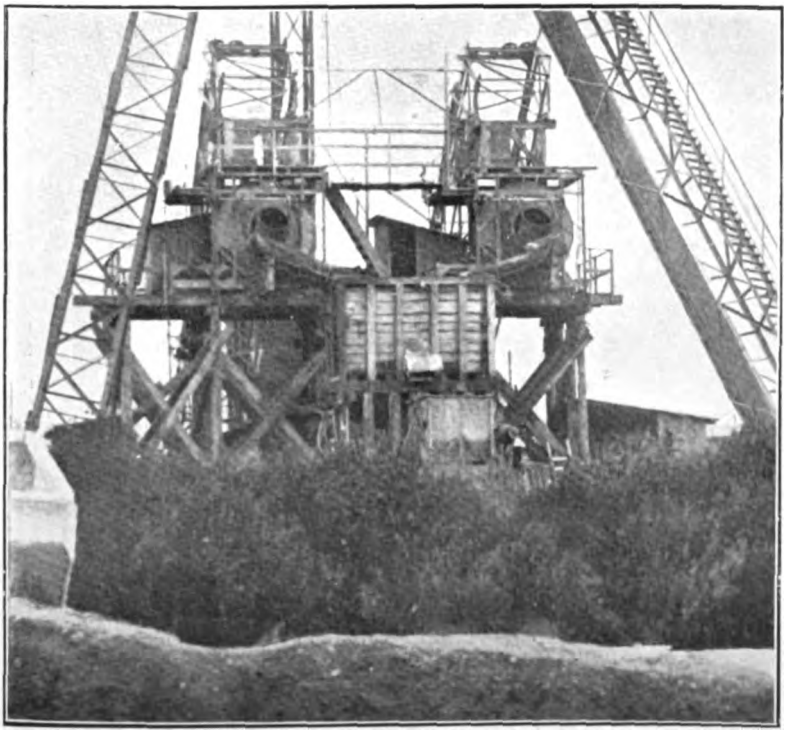

Photo 2.—Concrete Mixing Plant under Cable-crane Tripod.

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Photo 3. – Reinforced Concrete Road Bridge under construction.

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Photo 4.—Bank-building Machine.

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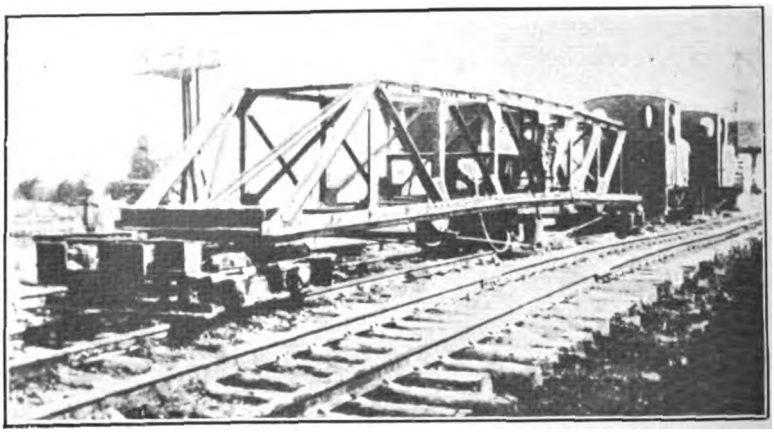

Photo 5.—Arbens-Kamera Track-shifter.

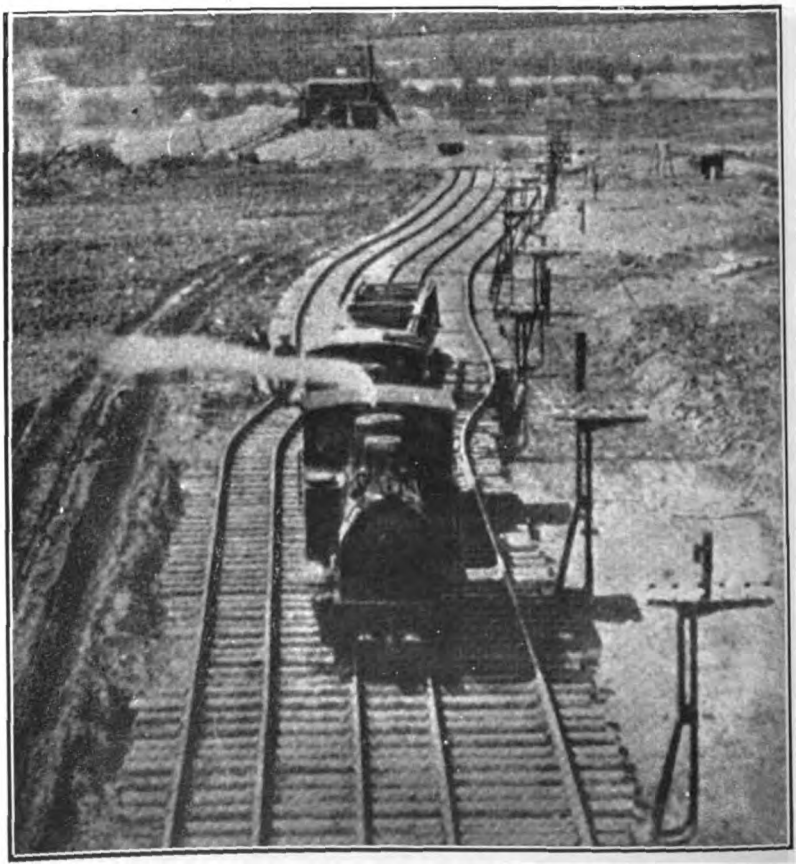

Photo 6.—Track-shifter at Work.

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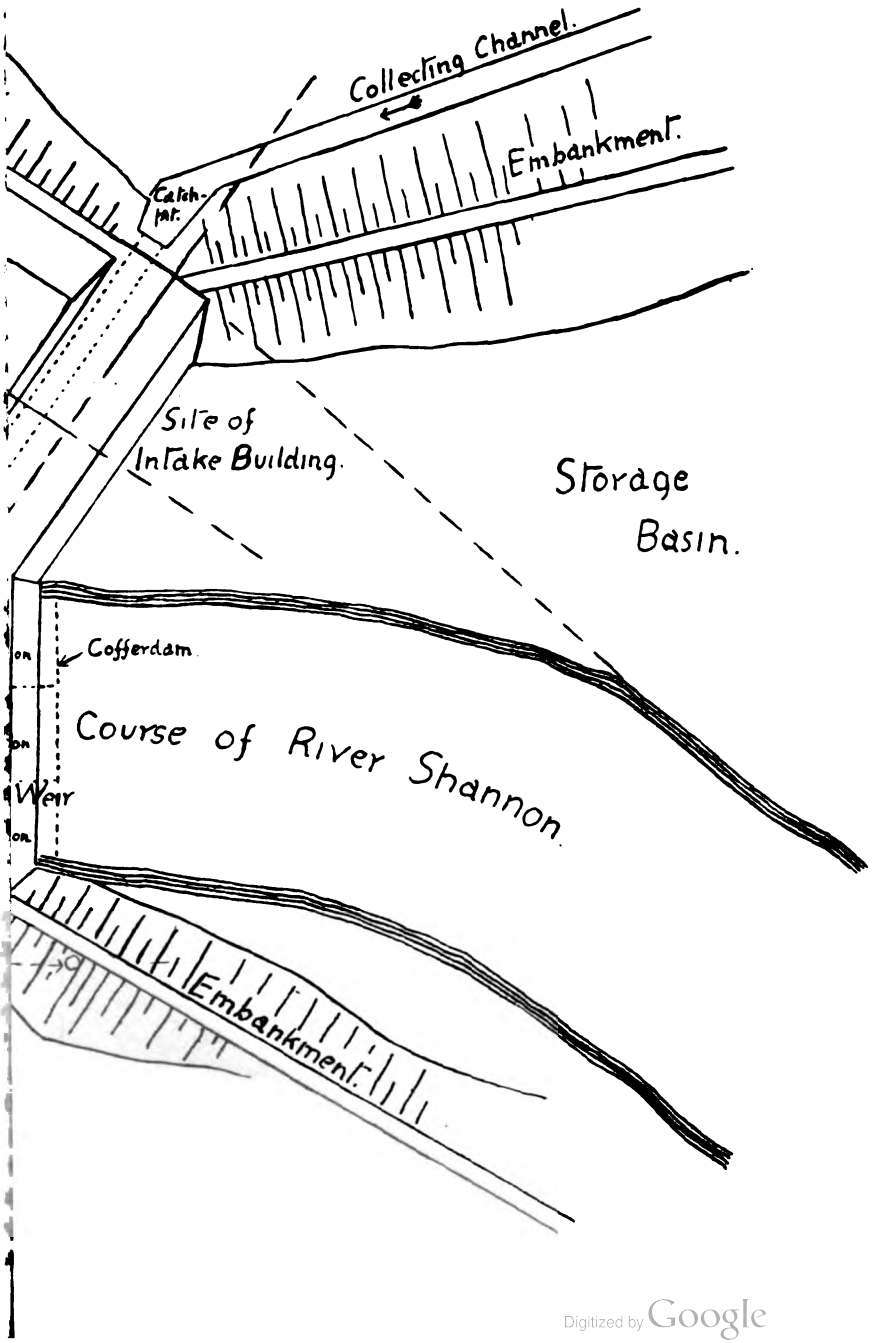
H PLAN OF HEADWORKS.—

About 50 yards to the Inch.



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The weakest link in the chain of operations seems to be the method of supplying the stone, which is drawn in tip-trucks up a ramp by means of a winch. At the time of the writer's visit, the plant could have dealt with stone at about three times the speed at which it was being delivered, in spite of the fact that the gang handling the trucks at the foot of the ramp were working quite smartly. The slow hauling speed accounted for most of the delay, the trucks taking nearly two minutes to traverse the ramp ; it would seem, therefore, that a more powerful winch would do something towards improving matters.

(*e*). *Concrete mixing plant.*

The arrangements for mixing and placing concrete at the power-station site are convenient and ingenious. The two mixers, which are supplied with material by the light railway, are mounted on a platform at the base of one of the cable crane tripods. (*See* Photo 2). The concrete is tipped into chutes, and discharged thence into skips, which the cable crane carries rapidly to any point within its range on the building site. The system depends upon the efficient working of the crane, but this seems to be quite reliable, provided the foremen can be induced to refrain from breaking the main cable by overloading it. The maximum permissible load is about five tons.

III. Concluding Remarks.

(*a*). *The German Invasion.*

The policy of peaceful penetration was one which had a great vogue in Germany in pre-war days, and it is now possible to see it being put into practice in the Irish Free State. Not only is the Limerick district being filled with skilled German artisans and their families, but it is said that estates are being bought up in increasing numbers by wealthy Germans in other parts of the country. Perhaps they will prove more fortunate than the previous owners, who in many cases had their homes burned about their ears. However that may be, one is repeatedly told that they are to be preferred to the British, though admittedly much of what one is told in Ireland has to be taken with a pinch of salt.

The popularity of the Germans on the Shannon workings is undoubtedly on the wane, as is also the reputation for infallibility which the German engineers enjoyed a year ago. It has been found by experience that even the methodical Teuton can make a mistake in levelling, and that having made it, he does not like being chaffed about it. It has further come to light that the German authorities are disconcertingly blarney-proof, and do not show the same admirable propensity for yielding to threats as the traditional British government. But, popular or unpopular, the skilful and industrious German workman is earning better wages in Ireland than he can in his own country, and is not likely to be easily ousted ; for it must be remembered that the energetic and ambitious among the Irish usually emigrate to America.

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(*b*). *Commercial and political aspect.*

Some of the difficulties foreshadowed in the last paragraph of the previous article are beginning to materialize. The citizens of Dublin are blessed with a highly efficient steam-power-station, owned by the municipality, which earns a substantial profit in relief of the rates. It is proposed to close down this station as soon as water-power is available, and much ink is likely to be spilt before all parties are satisfied.

In conclusion, the following rough figures for comparison with other schemes may be found of some interest. Owing to the lack of authoritative data on the subject, they must be regarded as a tentative estimate only, and should be accepted with caution.

1. *Output.*
   (1) Maximum, (a) Partial development, 56,500 kw.
   (b) Total development, 113, 000 kw.
   (2) Annual, at 30% load factor,
   (a) Partial development, 147½ million kw.h.
   (b) Total development, 295 million kw.h.
   (3) Per head of population, per annum at 30% load factor,
   (a) Partial development, 49·2 kw.h.
   (b) Total development, 98·4 kw.h.

2. *Charges.*

	Partial Development.	Total Development.
Total capital	£8,000,000	£10,000,000
Interest at 5%	£400,000	£500,000
Depreciation, on a quarter of capital at 10%	£200,000	£250,000
Running costs and wages ..	£100,000	£120,000
Total annual charges ..	£700,000	£870,000
Cost per kw.h. generated ..	1·13d.	·70d.

The above figures show very clearly how important a good load factor is to a development of this type, owing to the high capital cost. They also point to the desirability of encouraging the use of electricity so as to enable the total development to be effected.

Special low tariffs will no doubt be adopted for energy consumed during hours when the load is small, with a view to improving the load factor and increasing the number of units over which the charges have to be distributed. By this means the assumed load factor of thirty per cent. may well be exceeded, and the cost per unit reduced in consequence. On the figures as given, the development does not compare very favourably with the best modern steam stations.

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DEMOLITION OF CHIMNEY BY A TERRITORIAL FIELD COMPANY.

No. 1.—View showing arrangement of sills, wedges, props, caps, and packing pieces.

No. 6.—Showing that the bricks are sheared clean of mortar.

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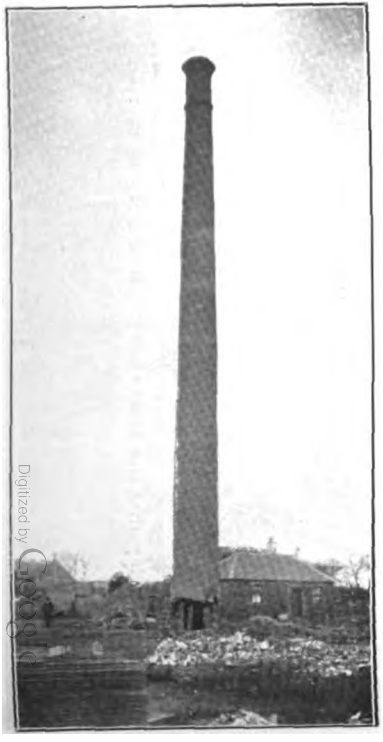
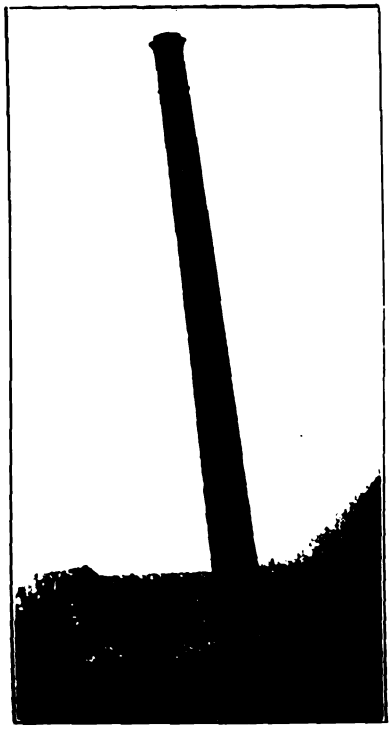
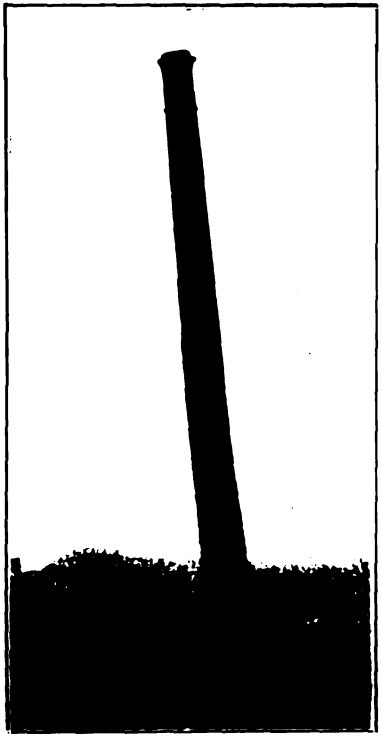


No. 2.—Showing the chimney after the various fuses had been lighted.



No. 3.—Shows the commencement of the fall.



No. 4.—A further stage.

No. 5.—Showing the finish of the fa

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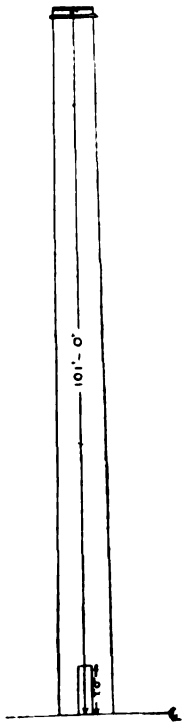

VATION OF CHIMNEY

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DEMOLITION OF CHIMNEY BY A TERRITORIAL FIELD COMPANY.

By LIEUT.-COLONEL H. S. TAWSE, R.E. (T.).

FOR the purpose of annual training in demolitions, the 236th (Highland) Field Company, R.E., T.A., recently demolished a brick chimney at a disused brickyard near Aberdeen. The chimney, which was 101 feet high, was felled by underpinning half the circumference with props, then shattering them with gun-cotton. This was accomplished by starting in the middle of the proposed breach and getting out sufficient brickwork to allow the first prop to be inserted. An additional section of brickwork was then removed to allow the second prop to be erected, and so on until all the props were placed in position. No explosives were used in the underpinning process, as an unforeseen collapse might have taken place owing to concussion.

The props were of larch, 9 in. diameter, and sat on two hardwood wedges, the top wedge being placed with the butt end towards the outside, so that when the props were shattered by the gun-cotton, which was placed about 9 in. from the bottom of the inside of the props, they would be forced outward, and slide off the wedges if not completely shattered. The hardwood wedges were placed on pitch-pine sills, which distributed the weight over as large an area as possible. Caps of similar dimensions were inserted between the tops of the props and the top of the breach, and, where necessary, packing pieces of pitch-pine were used between the props and the caps.

A slab of gun-cotton was placed against each prop, and exploded by means of *cordeau détonant* and safety-fuse. The charges were fired in rotation, starting from the centre of the breach and moving towards each end. The time was regulated by the length of safety-fuse used for each charge, about a second being allowed to elapse between each shot. The fuses and the timing were so arranged that prop A was blown first, then the two props B, and thirdly the two props C, as lettered on the accompanying plan. In addition to shooting out the props, two wingholes were drilled into the brickwork of the chimney at each end of the breach, charged similarly to the props, and exploded last, so that the breach became under the centre of gravity of the chimney, and so caused the collapse of the chimney in the required direction.

The demolition was carried out successfully by Territorial Sappers, previously untrained in demolitions and use of explosives. The direction of the fall was correct according to the line shown on the site plan, and well within the length previously allowed for the fall, which was two-thirds of the height of the chimney.

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A RECENT WIRELESS DEVELOPMENT.

By COLONEL F. A. ILES, C.B.E., D.S.O., R. OF O.

THE transformation of electrical into other forms of energy, light, heat, or mechanical energy, are still in the main confined to those cases where the place of origin and the place of manifestation are connected by live-wire. The radiation of energy by Hertzian waves permits us to dispense with the connecting electrical conductor, but the losses of energy are so great that transmission of energy without wires has hitherto not been extended beyond those cases in which the phenomena produced at a distance are achievable by minute currents, that is to say, not beyond wireless telegraphy and wireless telephony, including in the latter its best-known form, broadcasting. In this sense, wireless telegraphy must be understood as including its special case, wireless picture telegraphy and its offspring, still in the experimental stage, electrical vision. In its restricted sense it has these two things in common with wireless telephony, that it is a message-carrier, which works by conversion and re-conversion ; and that for normal working it requires, in order to deliver its message, the assistance of another medium, the air and its sound-waves.

Twenty years before the advent of wireless, the telephone had taught us that the air-vibrations which affect our ears, causing sound, also affect a microphone so as to bring about certain electrical effects, and that these electrical effects are by means of a telephone-receiver re-converted into sound-producing air-vibrations. The fidelity of the imitation would be startling in its realism if use had not familiarized us to the wonder of the telephone. What we hear from the telephone-receiver is none the less a reproduction, as is what we hear from a gramophone, only that, in the former case, the reproduction is instantaneous, and without record. Since electrical phenomena are the agents of this reproduction, and since these phenomena are clearly defined in the world of electricity, it is now possible to produce by electrical means alone that which has hitherto been arrived at only by conversion from sound ; in other words, to *produce* music instead of *re*producing it.

M. THÉREMIN.

Newspapers, in describing the invention of M. Théremin, by means of which this is done, have spoken of " the music of the spheres," or " music from the ether," have claimed that M. Théremin, " himself no musician," was drawing upon something supernatural. These

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utterances must be looked upon as the language of poetry. The music played by M. Théremin and his assistants and other experimenters following him, emanates not from the ether, but from the brain of the performer, and is expressed upon an instrument, consisting of wireless oscillating valves actuating a loud-speaker, which is just as truly a musical instrument, as if its music was the product of wind or strings. The proof of this statement lies in an examination of the conditions which M. Théremin's instrument, equally with wind and string-instruments, fulfils. What, then, are those conditions? When the state of equilibrium of an elastic body is disturbed by shock (produced either by impact or by friction), the body tends to regain its state of equilibrium by oscillations on either side of its original position. If these oscillations are of the requisite rapidity (say, more than 16 per second and less than 36,000 per second), air-vibrations are caused which in the human ear will produce sound The principal musical oscillators fall into two main classes, wind-instruments and string-instruments. In the former, the oscillating body is a column of air, in the latter the vibration is of solid bodies, so-called strings, actually of catgut or metal wire. That which is common to both classes is (1) elasticity, a term taken to include the capability of being displaced into a state of unstable equilibrium, and (2) inertia. These two attributes are not confined to musical oscillators: they are the essentials of any mechanical oscillating contrivance, whether sound-producing or not, such as a lath held at one end in a vice, and having a weight fastened to its free end; or a weight hanging by a helical spring. They are equally the essentials of an electrical oscillating circuit. In this case, the counterpart of mechanical elasticity is the interplay of lag and lead in current behind or ahead of potential, as the current charges alternately inductance or capacity: while the inertia is the current-strength, *i.e.*, the mass of the electrons carried. As for the reception of H.F. oscillations by the telephone-receiver, at a frequency of half-a-million, corresponding to a common wave-length, 600 metres, the telephone-receiver will not respond to them, being by reason of its inertia incapable of vibrating at such a speed. In any case, they would be inaudible at a frequency exceeding 36,000 per second, the upper limit of the human ear; and this corresponds to a wave-length of five miles, which is far outside the wave-length range of ordinary wireless stations. For reception the frequency of H.F. oscillations has consequently to be reduced to within the audibility limits. This is best done by the formation of beats.

Beats.

The formation of beats is a well-known phenomenon in sound. When two different notes, *i.e.*, sounds of different frequency, are sounded at the same time, one with a frequency of m per second, and

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the other with a frequency of n per second, they alternately strengthen and, owing to "interference," weaken each other, the combined sound rising to a maximum with a frequency of $m-n$, *i.e.*, there will be $m-n$ beats per second. A similar effect is observed with alternating currents, and also with H.F. oscillating currents. This formation of beats furnishes an easy means of rendering audible H.F. oscillations which occur above the range of audibility, since beats or maxima in the amplitude of the total current are formed when two H.F. oscillating currents of slightly different frequencies are superimposed. The frequency of the beat is arranged so as to produce a musical note in the telephones.

Beats are, however, met with, which are both unmusical and unintentional. The whistles and shrieks familiar to all listeners-in to broadcasting are beats caused by the combined effect of a wireless valve-receiver accidentally starting to radiate, while the broadcasting station is working. If a receiving-station inadvertently sets a valve oscillating so as to affect its own aerial, radiation takes place, and the case occurs of two frequencies being superimposed. If the beat thus produced is of a frequency between 10 and 70 per second, the noise made is very unpleasant, the maximum of dissonance being reached at about 30 beats per second.

Although the idea of music from wireless was no new one, dating as it did from 1900, and Duddell's Singing Arc, a precursor of the valve in producing continuous waves, it remained for M. Théremin to show how beats could be utilized for producing pleasing sounds according to plan.

APPARATUS.

In the first place, the instrument appears to include two valve-oscillators, normally of the same frequency. One valve is in a circuit of fixed frequency; the frequency of the circuit containing the other is variable, for the purpose of creating beats. The frequency of an oscillating circuit varies when either capacity or inductance is altered. M. Théremin changes the frequency of the beats between his two oscillating circuits so as to make musical sounds, and he does this in an original manner. The use of an upper and lower capacity, instead of aerial and earth, is well-known in wireless. It was the aerial equipment of early wagon-sets in the British Army. M. Théremin makes his valve, the frequency of the oscillations of which are to be varied, charge a capacity of which the upper portion is a metal rod and the lower portion is himself. The apparatus is sufficiently sensitive for a movement of his hand towards or away from the upper capacity (called by the newspapers the "antenna") to alter the strength of the field of electric strain between the two capacities, hence the total amount of "capacity" in the circuit, hence the frequency in the one circuit, and a beat is formed with the oscilla-

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tions of unvarying frequency in the circuit of the second valve. The beat thus formed is musical according to the performer's skill, and, by varying it, he is able to play tunes.

A third valve, coil-coupled to each of the first two valves, acts as a detector, by passing the superimposed oscillations through a transformer to the telephone-receiver or loud-speaker. Simple musical notes are thus obtained, but a great deal more is necessary before a performance can be given, and these additional requirements have also been tackled by M. Théremin with success.

As regards variations of intensity or loudness, these are done, in a much more mysterious manner, by the performer's other hand approaching or receding from a horizontal metallic ring known as the " power " antenna, to distinguish it from the " musical " antenna, the metal rod mentioned above. This hand, like the other, moves freely in the air without touching anything. It would, therefore, appear to work also by affecting capacity, but there is this great difference, that in the first case frequency is changed by change in capacity, while in the second case the circuit must be guarded against change of frequency by means of a stabilizer, in order to allow control over amplification.

As regards quality of tone, or *timbre*, M. Théremin has, in order to improve it, pressed into his service yet another source of trouble in wireless, viz., the formation of harmonics. This phenomenon, well understood in the study of sound, applies to H.F. oscillations equally as to taut strings, and has helped M. Théremin to imitate wind instruments, string instruments, and even the human voice.

Without going into the musical possibilities, either singly, orchestrally, or from a composer's point of view, of this latest achievement of that " wonderful lamp," the valve, it can safely be said that very great skill and judgment are required for a good performance on M. Théremin's invention, and this because, there being no keyboard, the performer must perforce play on imaginary keys. This difficulty has, however, already been got over by an improvement due to M. Bertrand, who, with an instrument on similar principles, has provided a keyboard in the shape of a semi-circular dial, upon which a movable pointer can be made to move in and out and to describe an arc of 180°. For any given piece of music, the dial can also do duty as score, since the positions of the notes can be marked beforehand, and straight lines be drawn joining these positions, to show the order of playing. There may well be a future for this instrument, in which but small skill on the part of the performer appears to be necessary.

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FORCED PASSAGE OF A RIVER BY MECHANIZED FORMATIONS.

By DR. OSKAR REGELE, Major, Vienna.

MECHANIZED formations are already included in certain armies amongst the regular arms of the service. These formations are entirely mechanized, and comprise no cavalry, infantry, nor horse-drawn transport.

The transport of a mechanized formation is formed of different types: motor cycles, motor cycles with side-cars, motor vehicles of all types and dimensions for personnel—together with motor lorries, mechanized artillery (hauled and self-propelled guns), pioneer and telegraph detachments, and, lastly, tanks of various types.

The principal mission of mechanized formations is rapid movement over great distances. No obstacles should, therefore, delay these vehicles very long, otherwise the advantage of speed is lost.

If mechanized formations are in reality to constitute a very mobile striking force, with which hitherto-unheard-of successes may reasonably be expected, it must be possible to use them at any point and over wide stretches of country.

Impassable mountains and rivers form two of the chief obstacles to be encountered by motor vehicles. Whereas, at present, impassable mountains absolutely preclude the employment of mechanized units, rivers may be crossed with the help of the Engineering Sections. In future, rivers will be of special importance in battle (operations), since they afford mechanized units very effective opportunities of defence. If, however, these units should not be capable of crossing rivers in face of the enemy, the value of these formations would be greatly reduced.

Mechanized formations must, therefore, be fully equipped and trained, to enable them to force the passage of rivers.

We will not at present consider the possibility of the use of swimming tanks. In their present form and technical development, they have not sufficient tactical mobility to cross a river held by the enemy, independently. The taking off and landing of these swimming tanks is a very laborious and slow operation, affording the defenders a good opportunity for well-aimed fire. An enemy equipped with good anti-tank weapons could very easily destroy attacking swimming tanks.

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If, however, a mechanized formation is not equipped with swimming tanks—which might, at times, succeed in crossing a defended river—an important question arises: how can a mechanized formation succeed in forcing the passage of a river in face of the enemy?

The problem of Artillery support is quite simple, as the method by which this artillery reach their fire positions on the other bank is immaterial. Nor need we enter into the question of air protection, which is indispensable in all river crossings in contact with the enemy, since this is organized by the Air Service itself.

But what troops should form the first assaulting units in the passage of the river? Here it is obvious that a mechanized formation must have at its disposal "light" units to lead the way across to the bank occupied by the enemy—infantry with a large number of M.G.s, anti-aircraft and anti-tank guns, light guns, cyclists. The task of these light units—which should lead the attack crossing the river in light pioneer craft (small boats)—is to occupy and hold a bridgehead on the further bank; heavy mechanized units can then be transported under their protection. It is impossible to convey motor cyclists, self-propelled artillery, or tanks—even if comparatively small and light—amongst the first units to the further bank. In consequence of their slow movements during shipping and landing, their large target-surface and great weight—they would be incapable of effecting the so-called "assault crossing," in which assault troops land quickly, carry their weapons without special difficulty, and do not increase the difficulty of the pioneers' work, as they row under enemy fire.

Should the light fighting forces succeed in occupying a bridgehead, their first care must be to secure the position against tank attacks by emplacing anti-tank weapons, for a skilful tank attack upon an enemy recently landed would, in any case, be most dangerous. Since, however, the halt at the bridgehead must be as short as possible—to avoid giving the enemy time for counter-measures, the troops required to follow up the attack upon the enemy must be brought up without delay. The transport of heavy mechanized units must, therefore, begin at once. This will only be practicable if the said units have at their disposal a large number of well-trained pioneers, with modern equipment. The transport of motor vehicles, guns and tanks requires a first-class pioneer unit. The successful exploitation of mechanization in battle, and during river operations, is entirely dependent upon the Pioneers, who go first and remove all obstacles which would impede the action of these vehicles.

In consideration of modern air warfare, which facilitates effective attacks upon military bridges, and since experience proves the impossibility of camouflaging them—it is advisable to avoid constructing them, and to concentrate upon ferrying. In future—and especially in daylight—it will be almost impossible to construct

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bridges, unless a force possesses overwhelming superiority in the air.

Even in the case of smaller streams, which might be crossed by ordinary tanks, it will be advisable to move light units first of all to the further bank. The very excellent bridging-tanks, which have proved so valuable (pioneer tanks, bridging wagons), can only extend their bays very slowly, and cannot carry out this work in face of the enemy without protection from their own guns. All motor vehicles which have to overcome lesser obstacles are obliged considerably to reduce their speed for this purpose; they must frequently halt for some moments, and—their accuracy of fire being decreased by the oscillation of the vehicle—thus afford favourable targets to the observant enemy.

The following conclusions may be stated as a result of the above considerations :—

(1). Mechanized formations, when forcing the passage of rivers, must have at their disposal light units, and also light pioneer equipment—transported, of course, in motor lorries —to enable them to form active and very mobile assault units.

(2). The bridgehead occupied must be effectively protected against tank attacks, until the tanks (and artillery) of the force in question arrive.

(3). Ferrying is always preferable to the construction of bridges.

(4). The number of pioneers available must be sufficient for the rapid transport of all sections of mechanized troops to the further bank. The pioneers must themselves be very mobile, in order to avoid any delays.

(5). The possibility of crossing rivers quickly and safely is one of the chief conditions for the successful employment of mechanized formations in future warfare

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THE CAMBRIDGE UNIVERSITY EAST GREENLAND EXPEDITION, 1926.

By LIEUT. P. F. WHITE, R.E.

BY the year 1926, the whole of the coasts of Greenland had been visited and surveyed, with the exception of a strip on the East Coast between latitudes 72° 00′ N. and 74° 30′ N. Between these latitudes lie, perhaps, the most interesting parts of the whole coast, including, as they do, the wonderful system of fiords discovered and surveyed by the Swedish Expedition in 1899. Although this and other expeditions had sailed as far inland as 100 miles from the sea, ice conditions had in all cases prevented them from landing on the outer coast.

The existing map of this coast was based on that made by William Scoresby, a Liverpool whaling captain, who, during the summer of 1822, made what has proved to be an extremely accurate survey of what he saw. Unfortunately, with the solitary exception of the region near Cape Simpson, on Traill Island, he never saw the actual coast at all. His work was carried out with a sextant from the crow's-nest of his ship, which could get no nearer than from 20 to 30 miles from the land. Much of this coast has a low-lying foreshore, stretching back sometimes as far as a mile to the foot of the mountains. That it was these mountains that Scoresby saw, and called Capes, is shown very clearly by comparing the excellent panorama he drew with photographs taken from positions closer in to the shore.

It was for this part of the coast that the party of eight members of Cambridge University left Aberdeen on June 30th, 1926, in the sealing ship s.s. *Heimland I.* Our leader, Mr. J. M. Wordie, M.A., (St. John's), had already, in 1923, attempted a similar expedition, but bad ice conditions had made it impossible to reach the coast, although within sight of it. (Two Sappers, R. H. Maclaren and C. C. Duchesne, went with this party.) Lars Jacobsen, the captain and owner of the ship, had with him a mate and a crew of eight Norwegians, who were as fine and helpful a lot of fellows as one could ever hope to meet. Our ship, steam-driven, but whose sails added an extra two knots in a good breeze, was extremely seaworthy. We all felt, however, that we should have preferred rather more than our 64 tons displacement, during the storms encountered on the homeward voyage.

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The expedition set out with the following objects :—

1. To carry out pendulum experiments on Sabine Island, a place where similar experiments had been carried out in 1823 by Capt. Sabine, R.A., a member of Capt. Clavering's party.
2. To carry out a topographical, geological, and ethnological survey of the coast between latitudes 72°00′ N. and 74°30′ N.
3. To locate, and, if possible, climb, Mt. Petermann, supposed by its discoverers, the German Expedition of 1870, to be the highest mountain in Greenland.
4. To send daily weather reports by wireless, and, if time permitted, to carry out some short-wave experiments with people in England.

We sailed first for Jan Mayern, by the Fair Isle passage, hoping to be able to land. Thick fog, however, preventing this, we established wireless communication, and made the necessary arrangements for them to listen morning and evening for our weather reports. Soon after leaving Jan Mayern, we met the edge of the ice, and followed it up to lat. 75° N. before turning westward. Within a few hours of entering the pack, we shot our first seal, so that, except for one week, we lived on fresh meat the whole trip. The ice proved exceptionally open. We tied up one night to an ice-floe to replenish our stock of fresh water from the pools on the floe, and to wait for fog to clear. On July 12th, within two and a half days from the time we turned into the pack, we came close to land in the fog. Next morning, when the fog cleared, we found we had anchored under the cliffs of Little Pendulum Island in one of the places recommended as a good anchorage by the "Arctic pilot." During our first evening on shore, we shot three brace of eiderduck, and the crew collected about 250 of their eggs, which made a very welcome addition to our larder.

As it had been impossible to make any exact plans before we knew when and where we were going to reach land, we now decided that, while the pendulum experiments were being carried out, we should give ourselves and our equipment a trial run on Sabine Island. This was invaluable, as it introduced us to the walking conditions which we were to meet throughout the trip, and gave us a good idea of what sort of loads we could conveniently carry. Walking in these parts is extremely tiring, as the ground is covered with loose stones. The hillsides are also mostly "scree," lying at its maximum angle of repose. There was never any danger of an avalanche, but, in climbing, one's feet slipped back a few inches at every step. In descending, this became an advantage, as one could run down for long distances: as much as 2,500 feet of descent could be accomplished in half-an-hour.

The sun had not set since July 3rd, so that time became a matter of indifference. We had our breakfast at 3 o'clock in the afternoon,

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if we had not found it convenient to go to bed before 6 a.m. At our first camping place we found an excellent pool, and bathed at midnight, drying afterwards in the sun (temperature about 50° F.).

Our tents were extremely good. They had a floor area of about 8′×8′, which was ample for two people in sleeping bags, and their total weight was about 13 lb. Our sleeping bags were of reindeer skin with the fur inside. Our only other special equipment was a suit consisting of trousers and pullover jumper, made of a light " windproof " material which had been tried out by the last Everest expedition. We found them invaluable when working on the top of a mountain, with the wind blowing. They were amply big, and were pulled on over our other clothing when required.

We were not troubled at all by cold. The general shade temperature was between 32° F. and 40° F., but went up to 60°—70° in the sun. After any strenuous climb we frequently undressed and bathed in the snow. On two occasions we bathed in the sea. Apart from this, our ablutions were very scanty, and, fortunately, not very necessary.

Just as the pendulum experiments had been finished, we had our one and only experience of an Arctic blizzard. Two of us were alone on Sabine Island, the remainder of the party having gone off in the ship in an attempt to sail round the north of the islands. At 9 a.m., we woke up to a calm, clear morning, and went to sleep again. By 10 a.m., a gale, estimated at 60 m.p.h., was blowing sleet upon us. The tent containing the pendulums was wrecked—fortunately without damage to instruments. Luckily, we saw the humour in the situation as we cooked our breakfast of porridge and pemmican on a " Primus " stove, while sitting in an ever-increasing pond, formed by the water dripping through the tent on to our absolutely impervious waterproof sheet. Breakfast finished, we packed up everything and moved into a wooden hut which had been built a few years previously by some trappers who had wintered there. The blizzard lasted for three complete days, and, to our great relief, the ship reappeared on the fourth evening. This experience might have ended far from happily, had not the Captain sensed the coming storm, and run the ship under the lee of Little Pendulum Island, for the dinghy left with us was washed away one night during a particularly high tide.

During their absence, the rest of the party had shot a walrus and two bears. A third bear, Susie, who is now in the Zoo, had been lassoed in the sea, and was in a crate on board.

Our next objective was the country round Clavering Island. Here we started our survey in earnest, and made our first important discovery, which we named Granta Fiord. In this neighbourhood we met musk oxen for the first time. After an all-night hunt we shot five, and spent the next twelve hours bringing the very welcome meat to the ship. The surveys of this neighbourhood being com-

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pleted, we set off south past Hold-with-Hope into Franz Joseph Fiord, with the object of attacking Mount Petermann while the weather was fine.

Franz Joseph Fiord presents wonderful views throughout its length of 100 miles. Generally about three miles across, its sides, bare of vegetation, and banded with the different colours of the various strata of rock, rise very steeply to an average of about 3,000 feet. Icebergs from the glaciers which feed the fiord abound and add extra charm to the scene. The head of the fiord is the finest of all, for here the mountains all rise to over 6,000 feet, and yet, owing to the large scale of the whole surroundings, do not appear to be half that height. The mountaineering party, after climbing 7,000 feet, found that Mt. Petermann was more than 20 miles inland, and that its ascent would be impossible in the time they had allowed themselves. They were, however, able to locate it definitely and, in addition, to discover another peak (about 11,000 ft.)—named Mt. Shackleton—which, we believe, to be higher than Mt. Petermann. There was, for these parts, quite luxuriant vegetation at the head of the fiord up to nearly 2,000 feet : bilberries, dwarf willows and harebells being commonest.

Before returning to the outer coast, we made a short stay in Musk Ox Fiord, in order to connect up our survey with that of Loch Fyne. Here we caught, in a net, a young musk ox, which soon became very tame, and wandered about the ship very happily. She, also, with Susie, was given to the Zoo.

I also managed to shoot the only large male bear we met. He appears to have been quite alone, as we did not see any more until we were 100 miles away.

Fog now put an end to the spell of about 150 hours of continuous sunshine which had attended us in the Fiord, and held us up for three very precious days. The fog did not extend higher than about 1,500 feet, and above this there was always a cloudless sky. It was when above the fog one evening that we saw our shadows on the fog below, surrounded by an aurora consisting of five concentric rainbow circles: a most curious and pretty effect which is discussed by Scoresby.

After a short visit to Jackson Island to finish off the coast of Hold-with-Hope, we started on our last lap—the coasts of Geographical Societies Island and Traill Island. As time was getting short, we worked in two relays throughout the 24 hours. By this means we were able to finish off the outer coast, but had to leave only partially complete the head of Mountnorris Inlet in Traill Island. Thanks to the absence of ice, we were able to land wherever we wanted, and so make a more accurate survey than had ever been possible before. We reached Mountnorris Inlet on August 21st, and as the weather appeared about to change we sailed south the next day. During the last week, we had been observing some beautiful effects of combined

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sunset and sunrise, about midnight, the former slowly merging into the latter.

Before returning home, we decided to visit the Eskimo Settlement in Scoresby Sound. Although we saw ample traces of previous Eskimo habitations in the country we visited, they all, for some unknown cause, have died out. The Scoresby Sound Settlement is an attempt on the part of the Danish Government to repopulate this district with pure-bred Eskimo from Angmassalik farther south. At the Settlement we met the Danish explorer, Dr. Lange Koch, who has travelled very extensively in Greenland, and who was now at the start of his winter stay, during which, in the spring of 1927, he made a 1,200 mile sledge journey to Denmark Haven (lat. 77° N.) and back.

A storm delayed our arrival at Reykjavik, the capital of Iceland, and kept us in harbour for four days. For the whole of this time we received the greatest hospitality from the British Consul, who arranged several interesting trips for us on the island.

Soon after leaving Reykjavik, we encountered another storm, which drove us north of the Faroes. Three times did the sea come over the stern of the ship, breaking the cabin skylight and dislodging everything aft. The crew collected seal skins and bags of straw soaked in oil, which they trailed behind the ship, and which prevented the waves from breaking over us more often.

We had to call at Lerwick, in the Shetlands, to take in water, so it was not until Sept. 8th that we finally reached Aberdeen harbour, having been absent ten weeks, and all sincerely regretting their termination.

The results of the expedition were laid before the Royal Geographical Society by Mr. Wordie (*Geographical Journal*, Sept., 1927), and the scientific side discussed. They may, however, be summarized briefly. The Pendulum results were very satisfactory. The unmapped portion of the sea coast was mapped with an accuracy quite sufficient for the purpose, and as great as could be expected with the instruments and time at our disposal. Signs of past Eskimo occupation were found wherever we landed, though none of recent date. (Living Eskimo were last seen here in 1823 by Capt. Clavering, R.N.) We found numerous winter houses, tent rings, and meat stores, also a few fox traps. We excavated three graves, and brought home the skeletons. With very few exceptions we sent out weather reports twice daily to Jan Mayern, who forwarded us an occasional message from home. We had no time to try any short-wave wireless experiments. These, fortunately, were relatively unimportant.

Although our time was very fully occupied, we managed to get quite a lot of shooting. Our bag included ten bears, musk oxen, two walrus, seals, hares, ptarmigan, and eider duck. All the bears, except one, we met on the coast; we saw one on the pack ice, but failed

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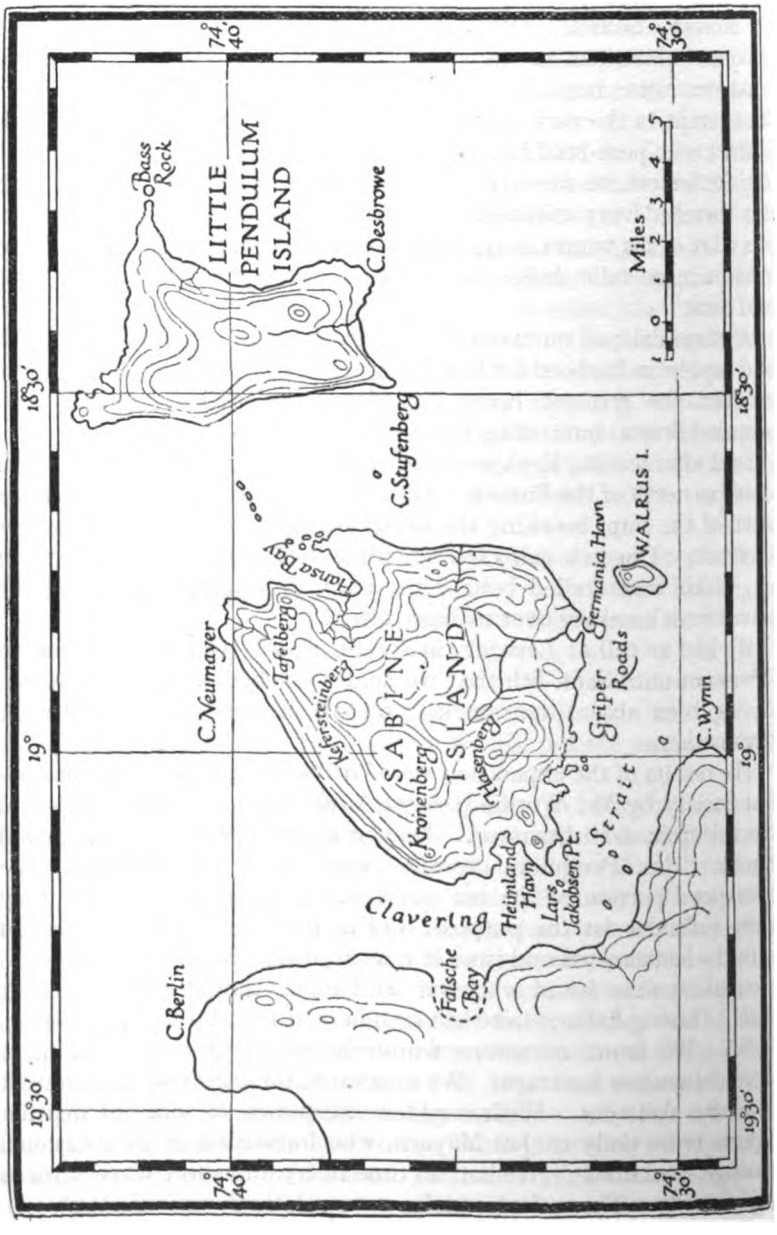

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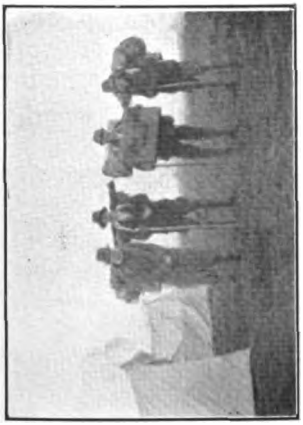
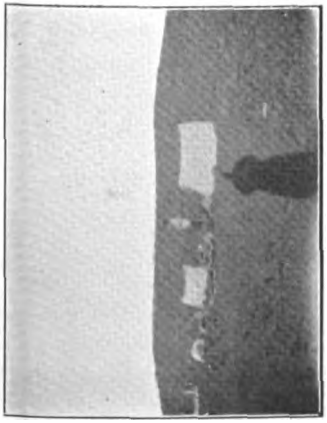
THE CAMBRIDGE UNIVERSITY EAST GREENLAND EXPEDITION, 1926.



Party on Trek.



Midnight Camp, Sabine Island.

Panoramic View of Granta Fiord.

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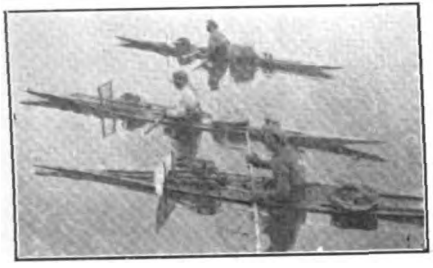

Eskimos in Kayaks.

Eskimos at Scoresby Sound.

Musk Oxen in Granta Fiord.

Payer Spitze.

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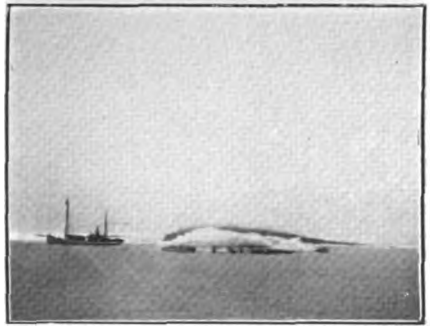
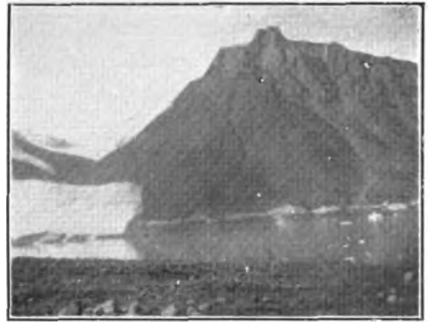
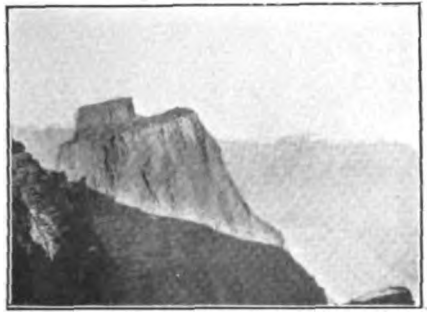


ss. Heimland I. off Walrus Island.



Ridderborgen (6,000 ft.).



Ridderborgen.

View from Summit of Ridderborgen.

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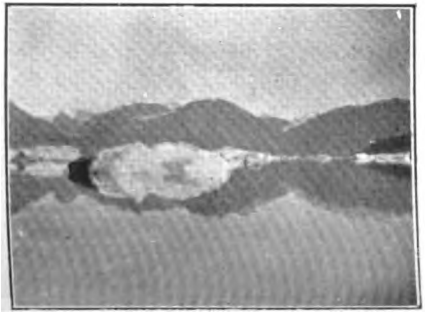
Franz Joseph Fiord.

Jordan Hill.



Ice in Kjerulf's Fiord.

Hansa Bay.

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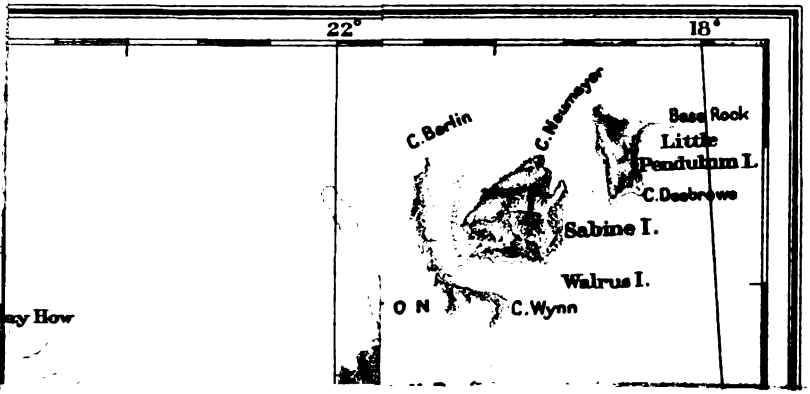

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to shoot it. Seals were plentiful everywhere, and we only shot them for a change of diet. We saw between two and three hundred musk oxen altogether. Like bear, they are very poor shooting, but, in both cases, the meat is excellent. The musk ox, apparently, can see only about ten yards, but their sense of smell is very keen. Bears, generally, take to the water, where they are easy prey. Our most exciting hunt was after a walrus, which, after being pursued for half-an-hour in a dinghy, was eventually harpooned by the captain. All the fat and the meat we did not require immediately was salted and put into barrels as a winter supply for the crew.

In conclusion, we all agreed that the scenery alone, from the first sight of the pack ice until the last, was almost worth the trip. Of the fiord type, this particular area, which is unique on the east coast of Greenland, must offer scenes without parallel anywhere in the world. Photographs cannot give any true idea of the beauty, as the colouring and vastness of the scale are essential features. Our chief regret was that we did not have time to explore King Oscar Fiord and its tributaries. The effect of refraction was very pronounced and beautiful. Icefields became rows of towers and minarets, with the whole inverted above them. Reflections of distant mountains were also seen upside down on the tops of the originals. This refraction proved very valuable in the survey as points below the horizon were so refracted that they became visible. Apart from super-mosquitoes in one or two isolated places, we had no minor worries, and were all extremely fit, breathing, as we did, air containing no germs of disease.

It is hoped that the foregoing remarks will encourage those who may get an opportunity to visit these or similar parts. There is still plenty of scientific work left to be done, and there are few finer places in which to take a holiday.

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RECREATION GROUNDS.

THEIR CONSTRUCTION AND MAINTENANCE.

By BT. LIEUT.-COLONEL G. B. O. TAYLOR, C.B.E., R.E.

Now that recreation grounds are authorized for the soldier, it is incumbent on the R.E. officer to have a working knowledge of the methods required for their construction, and of their maintenance.

Although the State does not normally maintain the grounds it provides—*vide R.E.S.*, para. 432, and Table L—it may happen that, in exceptional cases, such as when barracks remain empty over a season, it becomes necessary to do so in order to prevent these grounds falling back so seriously in condition as to necessitate reconstruction.

The actual scales of provision are laid down in *Barrack Synopsis*, and it will be seen from a study of these that the work required, from the engineering point of view, divides itself into three well-marked categories :—

(1) The provision of a playing area for football and cricket.
(2) The provision of tennis courts and cricket pitches.
(3) The provision of a running track.

Each of these requires different consideration and treatment.

(1) AREAS FOR FOOTBALL AND CRICKET.

It will seldom occur that available ground will be found sufficiently level and well grassed to enable it to be taken into use forthwith, and the first step is usually, therefore, to level an area of the extent required.

LEVELLING.

A football ground or the outfield of a cricket ground need not be dead level, in fact there is a considerable advantage to be gained in throwing precipitated moisture off quickly by having a gentle slope.

This slope, however, should not exceed 1/100 longitudinally, or 1/40 across the playing field, otherwise the slope will materially affect the play.

Cricket pitches, tennis courts, and running tracks, must be dead level, and it is desirable that areas devoted to hockey should be so also, although it should be noted in this connection that the State does not provide playing areas specifically for hockey.

When levelling is resorted to, the first step is to remove all turf from the surface. Any portions fit for re-use should be cut in proper fashion, *viz.*, in strips of suitable size, and rolled up or stacked grass inward, in some convenient spot.

The most convenient size for turves is a matter of opinion, but whatever the size, it must be uniform.

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The best is probably one foot square by 1½ in. thick, which is easily handled, and is better in every way than the three feet by one foot turves so frequently employed.

The latter have to be rolled, and, however carefully cut, there are certain to be irregularities which are fatal to the accuracy required in some instances.

Although such irregularities roll out, it is obvious that even consistency of soil, and therefore of growth, are no longer assured, and whereas before there was irregularity of surface, there is now unevenness of texture.

With a large playing area this is of minor importance, and the greater speed of laying of the 3 ft. by 1 ft. turves may render their use desirable.

Levels should then be taken over the area, and pegs put in at five-yard intervals, adjustment being made for any permissible slope given to the final surface.

The exact method of levelling and removing surplus soil, if any, depends on the nature of the soil, and the amount of excavation necessary, but every effort should be made to balance cut and fill, allowing for a final settlement of at least 15% in the fill.

The amount of soil required is largely a matter of opinion—where suitable turf existed before levelling it may be assumed that there is sufficient soil, and, whatever the sub-soil, all that is necessary is to ensure that the top spit is collected separately to start with, and spread over the final surface in a 6 in. to 8 in. layer as a last prelude to replacing the turf.

Where the soil is homogeneous to some depth, it is obviously unnecessary to collect the top spit and replace it as a separate measure. In any case, however, a finely raked compost immediately below the turf is of great assistance, as is the addition of an artificial manure, such as sulphate of ammonia, in inducing the roots to strike quickly.

Where the turf is unsuitable for relaying, it should be removed by ploughing off, and burned in " bee-hive " like heaps, to be used as a top dressing on the seed bed to be formed.

Burnt soil is invaluable in this connection, and has the further advantage that any weed seeds, which might otherwise have been in the soil, have been destroyed by the operation of burning.

PREPARATION OF FOUNDATION.

Good drainage is an essential for all playing areas, the amount varying with the texture of the soil ; considerations of cost, however, will usually only permit of its use sparingly.

The normal method of drainage is by mean of agricultural drains, *viz.*, butt-joined porous earthenware pipes of varying diameters, and two feet in length.

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The method of laying is to excavate main trenches at intervals along or across the area to be drained, with subsidiary branches or feeders in a herring-bone formation.

The actual distances apart are governed by the character of the soil, and the amount of water in it; but the average would be roughly :—

Main drains	100 ft. apart, 4 inches to 6" diam.
Feeders	15–25 ft. apart, 3" diam.
Fall, 1/40, Average depth ..	1 ft. to 2 ft. 6 in.

The distance apart of the feeders would vary according to the heaviness and water-holding capacity of the soil—a water-holding clay requiring feeders as close as 12–15 feet.

It is seldom advisable to reduce the size of the feeders below 3 in., as they tend to become blocked.

It is usually advisable to cover these drains with drawn wheat or rye straw, immediately surrounding the pipes, to prevent silting up, through fine ashes or sand percolating through the earthenware.

Failing straw, heather or bracken is serviceable, and will last several years. To enable storm water to run off quickly, the trenches should then be filled with clinker up to about 9 in. below the finished surface.

Shallow drains are best for stiff soils, but a greater depth is required for more porous soils—in gravelly soils two to three feet is suitable.

Even in such cases drainage definitely improves the turf, as not only does it sweeten, but it also raises the temperature of the soil.

On undrained soils the ground becomes hardened and parched up in dry weather.

On heavy soils a core of clean ashes is advisable, varying in thickness from 5 in. to 10 in.—although here, again, considerations of cost may make it prohibitive over any considerable area.

This core should be unrolled and laid in 3–4 in. layers, and raked to an even surface. Well-rotted stable manure can be intermixed with this core, with the object of tempting down the roots of the grass, and thus giving it a better opportunity of withstanding hard wear and drought.

It must be borne in mind, however, that grass is a surface-rooting plant, and that the effect of this intermixture of manure will be to encourage the growth of the coarser types, suitable for football fields, but not for tennis courts.

In cases where the turf is non-existent or unsuitable, there are only two alternatives to consider :—

(1) Turfing with turves obtained from a suitable locality.
(2) Seeding.

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Turfing.

Turves are comparatively expensive to buy, and very bulky to transport, and unless suitable turf is obtainable in the near vicinity, it may be taken as an axiom that seeding will always be resorted to.

The provision of more expensive kinds of turf, such as Estuary, Mountain, and Downland, will never be justifiable for playing fields for troops; and turf available in the locality must be used. In fact, to ensure success, any turf from outside sources should be obtained from soil of the same nature as that to which it is to be transferred.

Each type of grass grows best under its own particular conditions of soil, etc., and transference to another set of conditions—even if apparently more favourable—merely results in the eventual disappearance of that particular type, and its substitution by the indigenous grasses of the locality. On the other hand, coarse grasses can be refined down to quite good turf by the addition, within reason, of dressings of sand or of charcoal.

Surface dressings of soil in many cases do more harm than good, as the object to be attained is healthy surface root growth, whereas the addition of soil on the surface merely makes it more difficult to obtain this result.

Seeding.

The necessary seed should be bought from a reputable firm, any of whom stock suitable seed for various soils and purposes.

When seeding has to be resorted to, the top surface requires special treatment, to prepare it for the reception of the seed.

An even surface, even in physical texture and fertilizing value of soil, is the first essential.

With large areas, such as football fields, this top surface can be intermixed with well-rotted stable manure, in the proportion of 20–30 tons per acre. The ground should then be tilled and cross-tilled with a rotary cultivator, and worked out to a friable condition.

Sowing, to be effective, must be done evenly, and this is difficult when done by hand, even on a still day. It is best done, therefore, by mixing the seed beforehand with dry earth and sand, and scattering the augmented bulk in handfuls.

The sown seed should then be covered with a layer of sifted soil or sand, and then well rolled with a light roller.

The application of a suitable chemical manure prior to seeding is also very beneficial.

The normal amount of seed for playing fields is 5–10 bushels per acre, five being normally sufficient for larger areas such as football grounds.

There are only two periods for seeding—the autumn or the spring, and there are arguments for and against each.

Autumn-sowing cannot be too early, in case of summer droughts, or too late in case of early frosts.

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The time indicated, therefore, is late September or early October. Spring-sowing cannot be early, in case of late frosts, and must not be too late, in case of early drought, and should be, therefore, in March.

If autumn-sown, however, with reasonable weather, the pitch should be fit for play by the following spring year, whereas if spring-sowing is resorted to, the pitch is seldom fit for play until after the second winter.

Growth is seldom so luxuriant in the autumn as in the spring, but the ground being warmer than the air induces stronger root action, which enables the grasses to weather the winter with comparative safety, and to start away vigorously in the spring. Such grasses are less likely to succumb to drying winds, which often have a disastrous effect on the tender spring-sown ones.

In either case, certain precautions are necessary to ensure that a suitable grass surface is obtained.

These comprise, briefly :—

(1) The provision of scare-crows or some other device to frighten away birds.
(2) The constant removal by hand of loose stones working up to the surface.
(3) Scything when the young grass is two to three inches high. This induces greater root growth, and the thickening of the grass population.
(4) The next two or three cuts should also be done with the scythe, and the use of the mowing machine, with its harmful effects of wheel dragging on the sward, avoided, until the surface becomes firmly consolidated.
(5) Rolling at the correct time, *i.e.*, when the ground is drying, but not too dry. This can be done once or twice during the winter, particularly after hard frosts, when the grass plants tend to be become lifted from the ground, but not so as to cause surface caking, which may undo in one operation the work of a season.

There is no doubt that, on the whole, seeding is greatly to be preferred over turfing, for the following reasons :—

1. It is cheaper.
2. It is more reliable, and gives a cleaner surface eventually.
3. Special grasses can be selected to suit special conditions of soil, situation and climate.

It has the disadvantage of being much slower in giving the desired result of a sward fit for playing on, although this can be partly remedied by sowing more thickly and therefore at a greater cost in the beginning.

Cutting, when the turf is fully established, should never be stopped.

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Checking growth above the surface induces new growth under the soil, with the consequent production of a close turf.

Judicious raking helps in this, by aerating the latent buds below ground, and inducing them to fresh growth.

The prick roller also helps greatly in aerating the surface.

The raking of large areas is too laborious, and in these cases a brush-harrow should be employed. This is also beneficial in breaking up and scattering worm-casts, which might otherwise be rolled flat, and seal up the air ducts in the soil.

Fertilizers.

This incessant propagation of new growth causes a drain on the resources of the soil; hence the need for fertilizers.

The prime need is for nitrogen—much of which is provided in an ordinary field by the clovers.

As these are undesirable features for other reasons, it has to be supplied by other means, of which the principal are sulphate of ammonia or nitrate of soda; of the two, sulphate of ammonia is probably the better.

A suitable method of applying sulphate of ammonia is as follows:—

Mark out the area to be treated in plots of 100 sq. ft.

Find a small jam jar, to hold 5 oz. of sulphate. Put this into a 3-gallon can, with a rose to it, and stir well.

Distribute this on the 100 sq. feet, and immediately follow with a can of clear water.

The first application should be in April, and repeated every fortnight or so till October. The sulphate of ammonia will destroy all clover, pearl-wort, chickweed, daisies, plantains and coarse grass, but it takes at least a season's steady application to effect this result. If too much is put on at a time, scorching of the grass is almost certain to result.

Other methods of fertilizing and removing various weeds can be briefly summarized as follows:—

1. For annual top dressings:

½ cwt. finely sifted soil 1 lb. sulphate of ammonia 2 lb. steamed bone flour 1 lb. canary guano	per 30 sq. yd.

Alternatively, dried and well-rotted poultry manure, mixed fifty-fifty with dry soil at the rate of ¼ cwt. per 30 sq. yd.

Or, weathered soot broadcast at the rate of 1 lb. per 30 sq. yd., or 1½ cwt. per acre.

Or, incinerated sewage sludge at the rate of 6–8 tons per acre.

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2. Indirect manures—

Charcoal	2 tons per acre.
Sea sand	Ditto.
Salt	80 lb. per acre.

One or other of these can be used as an occasional top dressing to assist in the fining down of the grasses.

Lime is both a direct and indirect manure. The caustic forms are too drastic for lawns, and powdered chalk or limestone are preferable.

3. Weed eradication—

Moss—If due to poverty of soil, manure.
If due to acidity of soil, ground chalk.

Sorrel and docks—root out and apply ground chalk.

Plantains, thistles and dandelions—root out while ground is soft, or cut off and put thimbleful of sulphate of ammonia on each cut surface, or thrust into heart of each weed a wooden skewer dipped in hydrochloric acid.

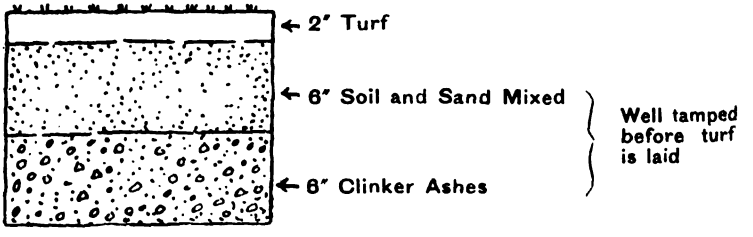
Daisies—Treat with lawn sand, *i.e.*, a mixture of 2 lb. sulphate of ammonia to ½ cwt. of finely-sifted soil; or lift and replace by clean turf.

(2). TENNIS COURTS AND CRICKET PITCHES.

More careful preparation, and a better surface texture, are required for these than for playing areas devoted to football, etc.

TENNIS COURTS.

The typical formation of a grass tennis-court is shown on the sketch below.



The object of the clinker is to provide an easily drained subsoil. It may also serve in preventing excessive downward growth of roots to limit the gross feeding of grasses where a rich and deep soil exists.

The intermediate layer ensures freedom from surface water logging, with its harmful effects on growth, and thus allowing for early play after rain; while at the same time providing nutriment for the grass.

SITING AND ORIENTATION.

Courts should be sited well away from trees, and particularly so that shadows do not fall on the court in the late afternoon.

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Apart from the inconvenience caused to the players, their shade causes patchy drying of the surface, and consequent variability in conditions of growth. The position and height above the horizon of the sun during playing hours must also be borne in mind.

The main axis of the court should lie, therefore, roughly in the N–S line, with perhaps a slight tendency to the East. Apart from the actual area occupied by the court, it is essential to provide sufficient space on either side and at each end, and the following will be found to be satisfactory allowances in this respect :—

At each end, 21 feet. At sides, 12 feet. Between adjacent courts, 8 feet.

In no case should a reduction of more than 25% be made in any of these.

CRICKET PITCHES.

These require a more durable and lasting surface than for any other purpose, the wear and tear being excessive.

It is essential, therefore, to prepare specially an area large enough to enable pitches to be moved frequently, and one 40 yards by 40 yards is normally considered sufficient for this purpose.

The requirements are a hard, true surface, covered with fine grass mown so closely that it scarcely seems to rise above the surface. Peaty or sandy soils require the addition of a more adhesive soil, such as marly clay, but to get the best results it requires to be mixed in with the native soil, and not laid on the surface.

A cricket pitch should be so constructed that rain water is carried away rapidly to enable play to be resumed quickly, and the most suitable form of construction is therefore as follows :—

Remove the surface soil from the pitch area to a depth of about 15 in. and level the sub-soil evenly and solidly.

On the top of this lay 3 in. agricultural drains in a circle round the area, with a 3 in. fall to the outlet, and cover them with rubble.

Avoid laying pipes through the centre, as this tends to form a depression.

Lay a 6 in. to 8 in. layer of broken chalk as a sub-base, then mix, if necessary, the surface soil with marly clay, and lay the mixture or the original soil in thin layers on the chalk, treading down each until brought up to the required level.

Then lay turf or sow selected seed. Sprinkle the surface with chemical manure, and roll a few times in moderately dry weather with a light roller.

Mow close on all favourable dry occasions until a month before play commences. Then bring into use the heavy roller, and continue to mow frequently and roll sufficiently to get a good pitch.

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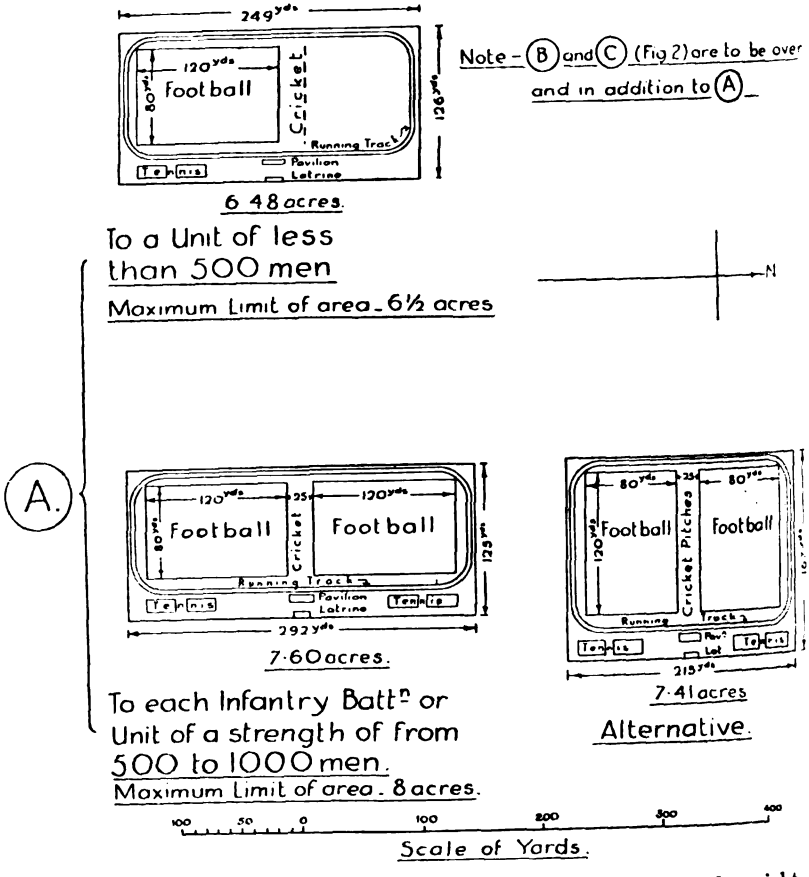
(3). RUNNING TRACKS.

These are authorized for all units, and for garrison grounds. In the former case grass tracks only are provided, and all that is required is to ensure that the playing area has a sufficiently wide grass verge to allow for a track round it.

In the latter case a cinder track is authorized.

The most suitable length for this is 440 yards, enabling the mile to be done in four laps, and it will be found that this length will enclose suitably a playing area comprising an Association football field, with a sufficient grass verge round the sides.

Fig. 1.



In any case it is essential that there should be stretches of straight of at least 100 yards in length, and that the bends should not be less than 30 yards radius.

It is of great advantage if a spur can be provided at one end to enable the 220 yards events to be run with only one easy bend to negotiate.

The width should be sufficient to enable four runners to compete

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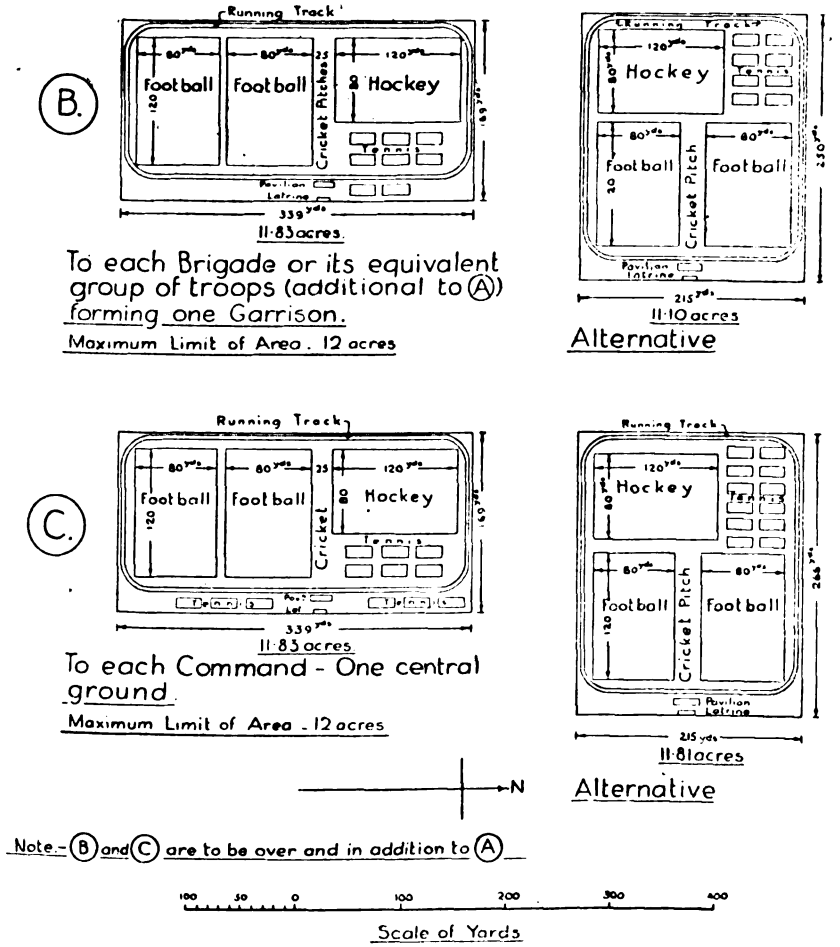
in the sprint events, running in strings, and should, therefore, be not less than 16 feet.

CONSTRUCTION.

The track is composed normally of 6 in. of well-sifted cinders on a 6 in. layer of clinker, broken brick or other suitable material. The formation level should be level, and rolled hard, and agricultural drains laid on its surface.

Fig. 2.



The 6 in. hard core layer should be laid on the top, and well compacted, and the cinders laid in 2 in. layers, each layer being well watered, rolled, and consolidated before the next one is laid.

Cinders for the top layer should pass through a 1/8th-inch mesh.

Subsequent maintenance consists of raking, watering, and rolling the surface, and removing any weeds, etc., which may spring up.

Lay-outs of recreation grounds, to suit various conditions, are shown in Figs. 1 and 2.

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OFF-LOADING PONTOON EQUIPMENT AND FORMING RAFTS FROM A SHIP.

By LIEUT. L. T. GROVE, R.E.

IT may often happen that pontoon equipment has to be transported by sea and off-loaded into the water at the destination, and taken ashore on rafts, and a case occurred this year when it was decided to form a pontooning camp near Weymouth. Several lessons were learnt as a result of this experience, and a brief report may therefore be of interest. The equipment consisted of 28 Mk. IV pontoons, with proportionate superstructure, weighing in all just over 64 tons. It was loaded in a small 300-ton coasting steamer, called *Sir Redvers Buller*. The full cargo capacity of these boats is about 70 tons, all carried in a single hold forward. A swinging derrick is available for off-loading. There is only room for 26 pontoons in one of these holds, so that this type of boat can only carry up to 14 bays of medium bridge, apart from trestles. In this case the two extra pontoons had to be brought along in a barge.

The first problem is to get the stores loaded at the base in the most convenient way. Whenever possible, loading should be supervised by an R.E. officer, or someone who understands the use of pontoon equipment. The easiest way undoubtedly is to lay all the road-bearers on the floor of the hold, where they all fit in very nicely. Then the pontoons are stacked on top. Chesses are piled in heaps at the side of the hold, which is not quite filled with pontoons. The more awkward units, compound joists, trestle legs, transoms, etc., are laid round the deck; they are not wanted for forming medium rafts, and simply get in the way. If this is not done, when the time comes to off-load, all the pontoons have to be taken out before the road-bearers can be raised to form rafts. This takes about two or three hours, and work is held up for that time, while the spare pontoons in the water are in the way, and may even be damaged if there is a swell running.

To simplify off-loading it is essential to have a proportion of road-bearers handy. These could be loaded between the separate layers of pontoons. There are actually four of these layers, and the best way is probably to have 20 road-bearers and 108 chesses between

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the first and second layers, and again between the third and fourth. Packing would not be quite so easy, but it should be quite feasible, and it would save quite two hours in unloading to form raft. Trestle legs and transoms are best at the bottom of the hold, right out of the way. Compound joists do not pack well, and there is room for them at the stern of the ship, on deck. It is essential to have plenty of breastlines handy from the first, and it is also a good thing to have anchors and cables on deck for the first two rafts.

Off-loading should be carried out on both sides, so that two rafts can be formed at the same time. There is no difficulty in this, provided the material is not all taken from one side of the hold. If this is done the ship heels over, and the derrick cannot reach over to the far side. Pontoons can be lifted quite easily with four slings round the handrails. Road-bearers present the most trouble. They come up best in bundles of five. It simplifies matters if the centre of each has been marked when loading, as they have to be lifted by one sling round the middle. They are very liable to swing, and all men in the hold must be told to stand clear. No pontoons should be opposite a bundle of joists which is being lifted. Once in the air they are quite easily guided by hand to where they are wanted.

If these stores are merely being transported by rafts, it is better to make these up with only five road-bearers. If the rafts have to come straight into bridge it would, of course, be necessary to put in seven straight away. The other stores are quite easy to lift, but the rate of working is slow, and the officer in charge has to decide beforehand exactly what the next load is to consist of, and have everything ready.

The best way to form rafts is to have the piers alongside and boom out. The road-bearers are lowered at right angles to the piers, and the pins must be placed in the saddle of the inside pier. The outside pier then booms itself out. It must have a breastline at each end, held by men on the deck of the ship, especially if there is any current running. It is usually better to double-chess straight away, as this leaves more room for other stores on deck. A rough guide for loading is to stop when the handrail is awash. If this is exceeded, the raft becomes rather unmanageable in a stream, and is very heavy to row.

The detail of working parties requires consideration. The largest number that could be usefully employed on forming a raft was found to be 12. To save time, three parties of twelve were used, one on each raft, and the third resting out of the way. Each party provides a small detachment to work in the hold. This may be from 2 to 4 men, according to the state of off-loading. It was found better to let each party do its own jobs, rather than keep spare men for the purpose,

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owing to the difficulty of supervising. These odd jobs keep cropping up, and a party gradually gets split up all over the ship. It is then better to call up the reserve party and take over completely, instead of trying to get the original party together again. This system was found to be more satisfactory than either time or task work, as the rate of off-loading with inexperienced men varies a great deal. As each party takes over, it can be given definite instructions to start on. Its subsequent procedure has to depend on circumstances.

When the rafts have been formed, it only remains to get them to the site. For this purpose the more men the better, up to the full complement of 22. So that, although only 36 men can be usefully employed on off-loading, owing to restrictions of space, many more are required in order to move off. A medium raft, loaded to the handrails, can be rowed against a current of two knots. Against anything stronger it is practically impossible to make any headway.

It is difficult to obtain an accurate estimate of the time such an operation should take. In the case described, 36 men did the work in about 20 working hours, including rowing the rafts for two miles against persistently unfavourable tides, but loading had not been supervised, and a lot of time was wasted on the first day before a successful organization of labour was arrived at. It then took about 1¼ hours to row the rafts up to the final site. Taking everything into consideration, it should be possible to get six medium rafts formed and loaded with superstructure in 8 to 10 working hours. This assumes no previous experience of such work, but favourable weather conditions, and properly supervised loading. The additional time required to get to the final site must depend entirely on the situation.

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CLIFFORD'S FORT, NORTH SHIELDS.

On May 12th, 1928, the Tyne Electrical Engineers, R.E., whose official designation is the 307th (Tyne) A.A.S.L. Co., vacated their old headquarters in Clifford's Fort, North Shields, and moved to their new drill hall beside Tynemouth Railway Station. They had been in occupation of Clifford's Fort since 1887, when the unit was first formed, under the title of the Tyne Division, Submarine Miners, R.E. Volunteers.

The troops paraded at Clifford's Fort, and, after the " Last Post " had been sounded, they marched with their Regimental Band to the parade ground on the new site, where the " Reveille " was sounded. The ceremony included the striking of the flag at Clifford's Fort just before the parade was marched off, and the breaking of the flag at the new Headquarters, immediately following the entrance of the troops. Many former officers of the Corps were present at the ceremony.

Clifford's Fort was built in 1672, during the Dutch Wars, in Charles II.'s reign. It mounted 40 guns, but was never under fire. It withstood, however, a " siege," or rather, an assault, in 1804, an account of which is reprinted from *The Shields Daily News* :—

" Perhaps the most interesting anecdote about the old place is the story of the celebrated ' siege ' in 1804. On April 30th of that year, the North Shields and Tynemouth Volunteers entered upon duty for one month. The guards at Clifford's Fort, Tynemouth Barracks, and the Spanish Battery, were delivered up to them. At Clifford's Fort the company had not been in occupation for more than four hours when Major Doyle, of the Light Brigade, from Sunderland, crossed the Tyne in a vessel, accompanied by one company of the 61st Regiment, one company of the Northumberland Militia, and one company Lanark Militia. The officers, it appears, had got rather vainglorious over their cups, and when disputing over the merits of their respective corps, the major had said he could easily surprise any of the forts garrisoned by the Volunteers, and he was dared to make the attempt. Unfortunately for himself, he chose Clifford's Fort as his intended victim.

" He landed with his troops in the early morning, and from the Lighthouse Sands proceeded as noiselessly as possible, the major leading on his charger, up the narrow passage close to the Fort. But before they could reach the gates, the Volunteers had made prepara-

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tions to receive them, their landing having been observed in spite of their caution.

"The number of Volunteers within the fort was insufficient for the guarding of the embrasures and the walls, however, so an 'express' was sent off for the remainder of the Corps, who happened to be on parade in Dockwray Square. These had already noticed what was going on, and they hastened down the bank to the assistance of their comrades. They forced the pass along the narrow passage mentioned above at the point of the bayonet.

"There was a sharp scuffle, and later the besiegers attempted to take the Fort by storm, but another attack in the rear saved the situation.

"Captain Robert Shield, of the Volunteers, was captured by the Northumberland Militia, but he was rescued.

"Meanwhile, the assailants of the Fort had been overpowered, and retreated sullenly to the flat-bottomed *Buonapart*, in which they had crossed the Tyne.

"But their cup of bitterness was not yet full, for on arriving at the Bents they found that a party of Volunteers, headed by Captain Shield, who was thirsting for revenge for being captured, had slipped across the river in scullerboats, and demolished the attackers' camp and carried off their flags. This was worse than defeat, as it involved disgrace, and it was many a long day before the incident was forgotten.

"The affair was a feather in the cap of the Volunteers, who proved themselves more than worthy of being entrusted with the Fort. The Fort was not built to resist a land attack, and it is interesting to note that one-third of the attacking party were soldiers of the line.

"Since 1860 the history of the Fort is somewhat uneventful. During that time, the march of progress brought about many changes in the place, and nearly all the old features became obsolete and disappeared."

The old fort, after this one eventful happening in its history, will now disappear, to make room for Fish Quay extensions.

The Editor is indebted to the Commanding Officer, Bt. Lieut.-Colonel N. H. Firmin, O.B.E., T.D., for the above information.

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BATTLE HONOURS OF ROYAL ENGINEER UNITS

(Continued from December, 1927, R.E. Journal).

ITALY.

PIAVE. 15TH TO 24TH JUNE, 1918.

Unit.	Formation.		Remarks.
54th Field Co.	7th Div.	D.	
95th ,,	,,	,,	
528th (Durham) Field Co.	,,	E.	
101st Field Co.	23rd Div.	,,	
102nd ,,	,,	,,	
128th ,,	,,	,,	
474th (S.M.) Field Co.	48th (S.M.) Div.	,,	
475th ,,	,,	,,	
477th ,,	,,	,,	
ARMY TROOPS.			
158th Army Troops Co. (A and C Sections).		N.E.	No diary.
285th Army Troops Co.		,,	No diary.
8th Mon. Army Troops Co.		,,	
No. 4 Pontoon Park (M.T.)		D.	
No. 5 ,, (H.T.)		E.	
No. 6 Field Survey Co.		D.	No diary.
No. 34 A.A. Searchlight Sec.		,,	No diary.

SIGNALS.

PIAVE. 15TH TO 24TH JUNE, 1918.

Unit.	Formation.		Remarks.
G.H.Q. Signal Co.	G.H.Q.	E.	
7th Divl. Signal Co.	7th Div.	D.	
23rd ,,	23rd ,,	E.	
48th ,,	48th ,,	,,	

VITTORIO VENETO. 24TH OCTOBER TO 4TH NOVEMBER, 1918.

Unit.	Formation.		Remarks.
474th (S.M.) Field Co.	48th (S.M. Div.)	E.	
475th ,,	,,	,,	
477th ,,	,,	,,	With XIV Corps.
XIV CORPS.			
54th Field Co.	7th Div.	E.	
95th ,,	,,	,,	
528th ,,	,,	,,	
101st ,,	23rd Div.	,,	
102nd ,,	,,	,,	
128th ,,	,,	,,	
ARMY TROOPS.			
158th Army Troops Co. (A and C Sections).		N.E.	No diary.
285th Army Troops Co.		,,	No diary.
8th Mon. Army Troops Co.		,,	
No. 4 Pontoon Park (M.T.)		E.	
No. 5 ,, (H.T.)		,,	
No. 6 Field Survey Co.		D.	No diary.
No. 34 A.A. Searchlight Sec.		,,	No diary.

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SIGNALS.

VITTORIO VENETO. 24TH OCTOBER TO 4TH NOVEMBER, 1918.

Unit.	Formation.		Remarks.
G.H.Q. Signal Co.		N.E.	
XIV Corps Signal Co.	XIV Corps	E.	
7th Divl. Signal Co.	7th Div.	,,	
23rd ,,	23rd ,,	,,	
48th ,,	48th ,,	,,	

MACEDONIA.

KOSTURINO. 7TH TO 8TH DECEMBER, 1915.

Unit.	Formation.		Remarks.
65th Field Co.	10th Div.	E.	
66th ,,	,,	,,	
85th ,,	,,	,,	No diary.

SIGNALS.

KOSTURINO. 7TH TO 8TH DECEMBER, 1915.

Unit.	Formation.		Remarks.
10th Divl. Signal Co.	10th Div.	E.	

STRUMA. 30TH SEPTEMBER TO 4TH OCTOBER, 1916.

Unit.	Formation.		Remarks.
XVI CORPS.			
65th Field Co.	10th Div.	E.	
66th ,,	,,	,,	
85th ,,	,,	,,	
17th ,,	27th Div.	N.E.	
1/1st Wessex Field Co.	,,	E.	
1/2nd ,,	,,	,,	
38th Field Co.	28th Div.	N.E.	
2/1st Northn. Field Co.	,,	E.	
1/7th Hants Field Co.	,,	,,	
143rd Army Troops Co.	XVI Corps	N.E.	
287th ,,	,,	,,	

SIGNALS.

STRUMA. 30TH SEPTEMBER TO 4TH OCTOBER, 1916.

Unit.	Formation.		Remarks.
XVI Corps Signal Co.	XVI Corps	D.	No diary.
10th Divl. Signal Co.	10th Div.	E.	
27th ,,	27th ,,	,,	
28th ,,	28th ,,	,,	

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DOIRAN, 1917. 24TH TO 25TH APRIL AND 8TH TO 9TH MAY, 1917.

Unit.	Formation.		Remarks.
XII Corps.			
99th Field Co.	22nd Div.	E.	
100th ,,	,,	,,	
127th ,,	,,	,,	
107th ,,	26th Div.	,,	
108th ,,	,,	,,	
131st ,,	,,	,,	
519th ,,	60th Div.	,,	
521st ,,	,,	,,	
522nd ,,	,,	,,	
9th Field Troop	XII Corps	N.E.	
137th Army Troops Co.	,,	,,	No diary.
140th ,,	,,	,,	
286th ,,	,,	,,	

SIGNALS.

DOIRAN, 1917. 24TH TO 25TH APRIL AND 8TH TO 9TH MAY, 1917.

Unit.	Formation.		Remarks.
M Corps Signal Co.	XII Corps	D.	
22nd Divl. Signal Co.	22nd Div.	E.	
26th ,,	26th ,,	,,	
60th ,,	60th ,,	,,	

DOIRAN, 1918. 18TH TO 19TH SEPTEMBER, 1918.

Unit.	Formation.		Remarks.
XII Corps.			
99th Field Co.	22nd Div.	E.	
100th ,,	,,	,,	
127th ,,	,,	,,	
107th ,,	26th Div.	,,	
108th ,,	,,	,,	
131st ,,	,,	,,	
17th ,,	27th Div.	N.E.	
500th (Wessex) Field Co.	,,	,,	
501st ,,	,,	,,	
37th Army Troops Co.	L. of C.	,,	
137th ,,	,,	,,	
139th ,,	,,	,,	
140th ,,	XII Corps	E.	
143rd ,,	,,	,,	
286th ,,	,,	,,	
117th Railway Co.	L. of C.	N.E.	
267th Railway Con. Co.	,,	,,	

SIGNALS.

DOIRAN, 1918. 18TH TO 19TH SEPTEMBER, 1918.

Unit.	Formation.		Remarks.
M Corps Signal Co.	XII Corps	E.	
22nd Divl Signal Co.	22nd Div.	,,	
26th ,,	26th ,,	,,	
27th ,,	27th ,,	D.	

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GALLIPOLI.

HELLES. 25TH APRIL TO 6TH JUNE, 1915.

Unit.	Formation.	Remarks.
All units E for "Landing at "Helles" and "Krithia," and, in addition, "Nil."	E. ,, ,,	

LANDING AT HELLES. 25TH AND 26TH APRIL, 1915.

Unit.	Formation.		Remarks.
2nd London Fd. Co.	29th Div.	E.	
1/2nd Lowland Fd. Co.	,,	,,	
1st W. Riding Fd. Co.	,,	,,	
1st London Div. Sig. Co.	,,	,,	No unit diary. Verified in diary of G.S. 29th Div.
No. 1 R.N. Div. Fd. Co.	R.N. Div.	N.E.	No unit diary. Verified in diary of B.G. R.E.
No. 2 ,,	,,	,,	,,
R.N. Div. Sig. Co.	,,	,,	,,
1/1st East Lancs. Fd. Co.	42nd Div.	,,	
1/2nd ,,	,,	,,	No unit diary. Verified in diary of B.G. R.E.
42nd (E.Lan.) Div. Sig. Co.	,,	,,	
2/1st Lowland Fd. Co.	52nd Div.	,,	
2/2nd ,,	,,	,,	
52nd Div. Sig. Co.	,,	,,	
1/2nd W. Lan. Fd. Co. (attd.)	,,	,,	
VIII Corps Sig. Co.	VIII Corps	,,	This unit disembarked on Peninsular 26.7.15. An A.T. Signal Co. is shown in a Transport return of 29th Div. relating to the Landing, but the unit cannot be identified.

KRITHIA. 4TH JUNE, 1915.

Unit.	Formation.		Remarks.
1/2nd Lowland Fd. Co.	29th Div.	E.	
2nd London Fd. Co.	,,	,,	
1st West Riding Fd. Co.	,,	,,	
29th Div. Sig. Co.	,,	,,	
No. 1 R.N. Div. Fd. Co.	R.N. Div.	,,	
No. 2 ,,	,,	,,	
R.N. Div. Sig. Co.	,,	,,	
1/1st East Lancs. Fd. Co.	42nd Div.	,,	
1/2nd ,,	,,	,,	
42nd E. Lan. Div. Sig. Co.	,,	,,	No unit diary. Presumptive evidence.
2/1st Lowland Fd. Co.	52nd Div.	N.E.	
2/2nd ,,	,,	,,	
1/2nd W. Lan. Fd. Co.	,,	,,	
52nd Div. Sig. Co.	,,	,,	
1/3rd Lanc. Works Co.	L. of C.	E.	No unit diary. A Lancashire Fusilier Co. is mentioned by B.G. R.E. was landing at Helles on 30.4.15; this is the only unit in Order of Battle which can be meant.

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ANZAC. 25TH APRIL TO 30TH JUNE, 1915.

Unit.	Formation	Remarks.
All units E for Landing at "Anzac" and "Defence of Anzac" and in addition 2nd New Zealand Fd. Co.	R.E. N.Z. and A Div.	E. ,, ,,

LANDING AT ANZAC. 25TH TO 26TH APRIL, 1915.

Unit.	Formation.	Remarks.
1st Aust. Fd. Co.	1st Aust. Div.	E.
2nd ,,	,,	,,
3rd ,,	,,	,,
1st Aust. Div. Sig. Co.	,,	,,
1st N.Z. Fd. Co.	N.Z. and A. Div.	,,
2nd ,,	,,	N.E.
1st N.Z. Field Troop	,,	,,
A. and N.Z. Div. Sig. Co.	,,	E.
Anzac Corps Sig. Co.	Anzac Corps	N.E.

DEFENCE OF ANZAC. 19TH TO 21ST MAY, 1915.

Unit.	Formation.	Remarks.
1st Aust. Fd. Co.	1st Aust. Div.	E.
2nd ,,	,,	,,
3rd ,,	,,	,,
1st Aust. Div. Sig. Co.	,,	,,
1st N.Z. Fd. Co.	N.Z. and A. Div.	,,
2nd ,,	,,	N.E.
1st N.Z. Fd. Troop	,,	E.
A. & N.Z. Div. Sig. Co.	,,	,,
Anzac Corps Sig. Co.	Anzac Corps	,,

SUVLA. 6TH TO 21ST AUGUST, 1915.

Unit.	Formation.	Remarks.
All units E for "Sari Bair" "Landing at Suvla," "Scimitar Hill," and in addition "Nil."		E. ,, ,,

SARI BAIR. 6TH TO 10TH AUGUST, 1915.

Unit.	Formation.	Remarks.
65th Field Co.	10th Div.	N.E.
66th ,,	,,	,,
88th ,,	,,	,,
10th Div. Sig. Co.	,,	,,
67th Field Co.	11th Div.	,,
68th ,,	,,	,,
86th ,,	,,	,,
11th Div. Sig. Co.	,,	,,

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SARI BAIR. 6TH TO 10TH AUGUST, 1915.

Unit.	Formation.		Remarks.
71st Field Co.	13th Div.	E.	
72nd ,,	,,	,,	
88th ,,	,,	,,	
15th Div. Sig. Co.	,,	,,	
1/2nd London Field Co.	29th Div.	N.E.	
1/2nd Lowland Field Co.	,,	,,	
1/1st W. Riding Field Co.	,,	,,	
29th Div. Sig. Co.	,,	,,	
R.E. Div. units of 42nd Div.	42nd Div.	,,	
R.E. Div. units of 52nd Div.	52nd Div.	,,	
R.E. Div. units of 53rd Div.	53rd Div.	,,	
R.E. Div. units of 54th Div.	54th Div.	,,	
R.E. Div. units of R.N. Div.	R.N. Div.	,,	
1st Aust. Field Co.	1st Aust. Div.	E.	
2nd ,,	,,	,,	
3rd ,,	,,	,,	
1st Aust. Div. Sig. Co.	,,	,,	
1st N.Z. Field Co.	N.Z. and A. Div.	E.	
2nd ,,	,,	,,	
1st N.Z. Field Troop	,,	,,	
A. and N.Z. Div. Sig. Co.	,,	,,	
R.E. units of 2nd Aust. Div.	2nd Aust. Div.	N.E.	
Anzac Corps Sig. Co.	Anzac Corps	E.	

LANDING AT SUVLA. 6TH TO 15TH AUGUST, 1915.

Unit.	Formation.		Remarks.
65th Field Co.	10th Div.	E.	
66th ,,	,,	,,	
85th ,,	,,	,,	No unit diary. Presumptive evidence.
67th ,,	11th Div.	,,	
68th ,,	,,	,,	
86th ,,	,,	,,	
11th Div. Sig. Co.	,,	,,	No unit diary. Presumptive evidence.
71st Field Co.	13th Div.	N.E.	
72nd ,,	,,	,,	
88th ,,	,,	,,	
13th Div. Sig. Co.	,,	,,	
1/2nd London Field Co.	29th Div.	,,	
1/2nd Lowland Field Co.	,,	,,	
1/1st W. Riding Fd. Co.	,,	,,	
29th Div. Sig. Co.	,,	,,	
R.E. Div. units of 42nd Div.	42nd Div.	,,	
R.E. Div. units of 52nd Div.	52nd Div.	,,	
1/1st Welsh Field Co.	53rd Div.	E.	
2/1st ,,	,,	,,	No unit diary. Presumptive evidence.
2/1st Cheshire Field Co.	,,	,,	
53rd Div. Sig. Co.	,,	,,	
1/2nd E. Anglian Field Co.	54th Div.	N.E.	
2/1st ,,	,,	,,	
54th Div. Sig. Co.	,,	,,	
1st Aust. Field Co.	1st Aust. Div.	N.E.	
2nd ,,	,,	,,	
3rd ,,	,,	,,	
1st Aust. Div. Sig. Co.	,,	,,	
1st N.Z. Field Co.	N.Z. and A. Div.	,,	
2nd ,,	,,	,,	
1st N.Z. Field Troop	,,	,,	
A. & N.Z. Div. Sig. Co.	,,	,,	

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and Rio (6,000 miles), working five nights a week sending pictures and handwriting on wave-lengths, first of 30 metres and later of 25. The times taken for a 1 sq. dm. picture, as above, are Nauen-Rome 80 seconds, Nauen-Rio 5 minutes (corresponding to 60–80 w.p.m. of Morse, which is above hand-speed). Between Berlin and Leipzig the same-size picture has been received on 850 metres in 30 seconds (corresponding to Morse high-speed). Atmospherics do not affect these pictures appreciably, appearing only as fine broken lines.

As regards the utility of picture-telegraphy and its future, the Army will find it indispensable for meteor charts, and, if introduced far enough forward, it will be able to give information which it is hard to express in words, thus saving cumbersome (and often inadequate) references to the gridded map in the body of the telegram.

In the matter of sending messages overseas, Lt.-Col. Boelcke modestly claims second place for facsimile telegraphy after the aeroplane or airship. It is, however, not easy to see how these latter will ever be able to compete over long distances with a message-carrying agency which can convey a message in perfect facsimile 6,000 miles in 5 minutes!

The future of picture-telegraphy across the seas will rather be the conquest of the mail-bag. Business firms will not send important letters too long for cabling on journeys of weeks to Australia, S. America or Japan, when at reasonable cost they can telegraph in facsimile and receive an answer in 48 hours. Even private people who can afford it will do their correspondence that way.

As regards the question of Electrical Vision, the Carolus cell is capable of dealing with 100,000 picture-elements in a second, *i.e.*, with 10,000 in 1/10th of a second, which is both the duration of time a light-impression affects the retina, and the period within which all light-impressions received appear simultaneous. With only 10,000 elements to the picture, we must either abandon all idea of getting the same degree of definition as in the Nauen-Rio trials, or be satisfied with a picture 2 x 2 cm., say 1 in. square. Further, for electrical vision the chief difficulty is the adequate illumination of the object, since the light-electric cell is not sensitive enough for ordinary light. When it is a question of broadcasting films, the matter becomes simpler, for the film can be directed so that a ray of light from a powerful source passes through it. That special case of electrical vision, the broadcast cinema film, may, therefore, be expected to arrive before electrical vision proper.

A footnote to the article, saying that permanent picture-telegraphy was established between Berlin and Vienna on December 1st, 1927, is misleading to this extent, that the article deals with wireless picture-telegraphy throughout, that the Telefunken-Siemens-Carolus is a wireless system, while the P/T established between Berlin and Vienna on 1.12.27 was done only by taking advantage of the then recently-laid Berlin-Vienna cable.

Mechanical Transport and War. The translation of Col. Maltese's article from the Italian finishes in this number. This third instalment, dealing with artillery tractors, tanks, armoured cars and M.T. columns, is too sound for exception to be taken to any points.

The author points out the effect that army M.T. requirements in war

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must have upon civil M.T. construction in peace, and sums up: A far greater use of M.T. will be necessary in future than was the case in the last War; animal transport will be confined to first-line troops in mountain country; there will be no horsed transport in Corps or Army areas. The wide extension of M.T. in armies will introduce a different time-scale, tending to bring about a very severe but very short period of mobile warfare. There will be incorporated into every army of fighting men a second army of engines and steel, and these two armies must be welded into solidarity in order to afford the necessary mutual support under all circumstances. Every effort must be made to instil into the troops an instinct-like feeling for the technical side. A spirit of disciplined economy will form part of the true understanding. If the troops are so trained, M.T. will gain in its powers more than if it was doubled in numbers.

With all this the German translator cordially agrees.

The Significance of the Air Forces. Certain photographs, which appeared in *Flight*, of detachments of the 53rd and 54th London A.A. Artillery Brigades taking part in the Lord Mayor's Show, and of a DH9 accompanied by auxiliaries, have given rise to an instance of relativity. To the German reviewer they " throw a characteristic light on how far the recognition of the significance of the Air Forces has penetrated into all classes of the population in England." The gallant Territorials who sacrificed themselves on this occasion, in order to give their units a much-needed advertisement, and in the hopes of attracting a few recruits, will find the German view singularly refreshing.

F.A.I.

MILITÄRWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(NOVEMBER–DECEMBER, 1927, CONTINUED.)

Chemical Warfare and International Law. The author of " Chemical Warfare," Dr. R. Hanslian, (*R.E. Journal*, March, 1928), reviews a pamphlet with the above title by Dr. Kunz of Vienna. The reviewer finds no fault with Dr. Kunz's conclusion that the German gas attack at Ypres on 22nd April, 1915, was no breach of international law, but is surprised to find that the use by the French of gas shells (Phosgene) early in 1916 " cannot be proved conclusively to have been contrary to the international law which was valid at the time." When the result of Dr. Kunz's " excellent labour, built up on a wide knowledge of literature, brilliantly formulated and carried through with astonishing logic," leads him to demand by means of international treaty an unconditional ban on the use of gas in war, not only of poison gases but of irritants, Dr. Hanslian can only call it " tragic." He thereupon sets himself two questions to answer, viz., Can—and should—chemical warfare be forbidden? As regards possibility there are two standpoints, tactical and technical. " As long as war is the *ultima ratio* of nations so long will chemical means of warfare be retained, since in the war-history of all countries and times

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no case is known in which a tactical advantage or a successful new weapon was ever given up again, once its value had been recognized and proven, excepting only to be ousted by a better one." The tactical answer is therefore " No." Again, at the conference at the Hague in 1899 it was pointed out that " the occurrence of poisonous gases (Carbon monoxide, Nitrous gases, Picric Acid) from the explosion, especially of shells of large calibre, was absolutely unavoidable and so could not be forbidden except by forbidding the use of all explosive shell." In the development of shell-ammunition which is to be expected in future, both in the form of shell of large calibre and of aerial bombs or torpedoes, in all of which new detonation gases, or in certain cases deflagration gases, will occur, we may expect that the line between explosive and gas will be wiped out to a still greater extent. Also, the use of smoke for protection will certainly increase, and will complicate the unequivocal determination of the use of gas by the enemy. It will in all probability be extraordinarily difficult in future wars, in cases other than that of discharge by cylinders in large numbers, to determine with certainty whether the enemy has in fact made use of gas or not. In such uncertainty lies the germ of misunderstandings and of reprisals, as we saw in the Great War. Thus the possibility of excluding chemical means from future warfare cannot be admitted from a technical standpoint.

The second question remains, and may be expanded thus: Supposing it were possible to frame international laws forbidding any intentional use of typically poisonous and suffocating gases, should this be attempted? The author thinks not, considering the matter of no great importance, inasmuch as war experience has shown that the most poisonous gases were not the most militarily effective. The gases which were the most militarily effective were the harmless ones, like the lachrymatories, which caused no deaths, or like the vesicatories, which killed one-tenth the number killed by explosive-shell. In other words, the poisonous and suffocating gases of the Great War will rule themselves out in future wars as ineffective, without being forbidden. There is still, of course, the possibility of new gases being discovered, both poisonous and militarily effective, but such surprises through some specially effective weapon are not limited to chemical means, and are consequently no reason for forbidding a means of fighting of which the development has hitherto been more humane.

As regards the latter point Dr. Hanslian records the unanimous decision of the American Legion, or comrades of the Great War, in their annual congress at Philadelphia, that the use of chemical weapons should be permitted in future wars, and that to forbid this method of fighting would be tantamount to wishing to replace a modern humane method of fighting by earlier barbaric methods.

Railways in War (continued). By General Ratzenhoper. The military effect upon the national railways of the movement of troops to war stations and the military capacity of the railways were laid down in the War Traffic Regulations. In order to guarantee the safety and regularity of ordinary traffic these Regulations arranged for all military trains to travel at slow speed, to take the same time between stations, and to have the same length of halts. As this procedure has come in for much

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criticism it may be as well to examine it more closely. Since the forward movement by train lasted some weeks, the decisive factor, in converting troops which are ready to move to the theatre of war into troops in the field, is not the speed of the trains but the total number of trains moved in a given time. If, as was the case, owing to the large amount of rolling-stock available, troops have not to be kept waiting for trains to be returned from the front, the time their journey takes is of quite subordinate importance. The objection that later in the war military traffic moved much faster proves nothing, since more powerful locomotives were constantly being provided. It was reasons of safety which, at the beginning of the war, dictated a system which made all troop-trains halt at rationing places for the same length of time as a ration-train took to load; but the system was changed later when the position as regards locomotives improved and when the lines leading forward were no longer all required for military purposes at the same time.

The rest of the article deals with the arrangements for the evacuation of wounded, the provision of coal (so that no coal trains were required for the first eight weeks of war), guarding against sabotage (83,000 men were employed and the total loss was one bridge), the provision of break-down gangs, the provision of spare bridges, the arrangements for possible demolition (137 tons of explosive in 309 built-in mine chambers).

The author also disposes of the complaint against the military authorities that they held up the electrification of the Austrian railways. —(*To be continued.*)

The Future of the Infantry Rifle. Major Markgraf leads up to his subject by pointing out the position of the rifle at the beginning of the Great War, when in masses it was the chief means of conducting the fight for fire-superiority, while the *rôle* of the few machine-guns then existing was to increase the fire-effect of the infantry. The machine-gun, in 1914 still a new weapon, was being used only tentatively, but its powerful fire-effect was soon recognized, and the call for its increase in numbers became loud. Besides this, the second half of the War produced the light m.g., which more and more took over fire-effect, leaving to the rifleman mobility and shock-tactics. The m.g. in taking over the mass-fire of the infantry rifle became the principal support of the infantry combat at all ranges. According to modern views, the infantry rifles, no longer appearing in masses, are to be brought as much as possible without firing a shot to short-range, say 500 m., and then for the first time, and subsequently at close quarters, are to complete the effect of the m.g's, heavy and light, and of the artillery. It is no wonder that, since the War, under the pressure of new weapons, the *rôle* of the infantry rifle has in many directions been regarded as played out: the idea being that the m.g. conquers the ground, the infantry, with their sparse numbers still armed with the rifle, only occupies it.

It is in respect to the development and views mentioned that the author now sets himself the task of determining what is to be the future of the infantry rifle. Comparing the pre-war requirements of the rifle with the demands now made upon it in accordance with modern opinion, he finds that the chief difference lies in the greatest possible range no longer being demanded. The heavy m.g. has taken over from the rifle

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fire-effect at medium and long ranges, and to this weapon the demand for increase of ranges has passed over. Low trajectory for the rifle is no longer of importance beyond the 500 m. limit set by the depth of the fire-fight zone. Rapidity of fire is of increased importance. The War showed the deficiency of the magazine-rifle in this respect, a partial remedy to which was brought out by the Germans in the shape of a 25-cartridge magazine. The new rifle must, therefore, be automatic. There is ample justification for this demand, and the objection of possible waste of ammunition is hardly worth consideration. The same objection was made to the introduction of the magazine-rifle. The infantry rifle will certainly have to fire very rapidly, but generally only for the utilization of rapidly-fleeting opportunities. It will not be kept in continual use, but will be required normally for sudden short bursts of fire at short ranges. As regards calibre, universal calibre or the same cartridge for rifle and for the different types of m.g. cannot be maintained. Only the light m.g. can still be classed in this respect with the infantry rifle. With the heavy m.g. two kinds of ammunition are necessary, differing in shape of bullet and in charge, apart from the different m.g. calibre for anti-tank defence and A.A. defence, and special ammunition (tracer, armour-piercing, ranging). The necessity of special ammunition (armour-piercing and tracer) for the automatic rifle, also materially influences the calibre question. The lowest limit for the manufacture of such ammunition is 7 mm. This calibre is ballistically suitable for the light m.g. as well as for the new rifle. It allows of a very necessary increase in the number of rounds carried by the man, 120 of 8 mm. (·255 in.), without increasing his load of 9 lb., sufficiently preserves man-stopping power, and permits the manufacture of special ammunition. The article concludes by pointing out that under the leadership of the United States the present armed nations are tending to the light m.g., followed by the automatic rifle.

The Officer and War Technics. This essay, by Major Angelis, was a prize-winner in a competition for the best answer to the question, " To what extent is a knowledge of war-technics necessary for every officer ? " It is carefully written, logical, well thought out, and full of statements which are incontrovertible ; in fact, it is exactly what is supposed to please most examiners. There is little trace of originality or of brilliance of thought or diction ; and disappointment awaits him who reads eagerly in order to learn. Since the new truths of the older generation are the platitudes of the young, a Board of Examiners consisting of Woolwich and Sandhurst cadets would probably have marked this essay low. They would have been wrong. The essay must be praised, even if it is praised with faint damns.

After defining Technics as the translation into reality of the development of science, the author divides War-Technics into two classes : (*a*) Weapons, chemical warfare, signals, and military engineering, (*b*) Transport and aviation. His answer may be summarized as follows :— On the foundation of a certain general education and a thorough military education (extending in the former case to such a stage of mathematics and science as to make possible the technical studies of the latter), all officers are to continue their education in war-technics. Their object

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to be, not so much actual knowledge as such, but the knowledge that increases understanding. Such study to be undertaken under expert guidance, and to be practical rather than theoretical, since war-technics, concerned with material, has become an indispensable ancillary in the art of war, which remains a thing of the spirit.

Flash-Spotting and Sound-Ranging. The translation of an article written for the Czecho-Slovakian army, in which these artillery aids are unknown. It deals with reaction-errors, the effects of temperature and wind upon the velocity of sound, and the correction of range owing to height differences—in short, with the elementary theory of the subject, and makes no mention either of apparatus or achievements.

The Technical Arms and Services. Col. Paschck having dealt with the Engineers in his last article, now continues with Communication-troops, under which heading are grouped together services as diverse as Signals and Transport (Railways, Water Transport, Mechanical and Horsed Transport, and Air Transport). The modern army spends on communications out of all comparison more than has hitherto been spent for these services. Needs continually grow, and technics are progressing. Excepting in Railways and Horsed Transport everything is very much in a state of flux.

Like Engineers, Communication-troops tend to become increasingly "Arms," and not "Services," depending in this case on whether they are serving operations or supplies, G. or Q.

As the first of the group, Signals are then dealt with under the headings "Means," "Principles of Employment," "Principles of Organization," "Signal Troops," "Regimental Signals," "Peace Organization," "War Organization." As he did with the Engineers, the author endeavours to show in some detail under "War Organization" what he considers the Signals of the great military powers are becoming. He points out that England, which is leading in mechanization, is likely to be the first to go over principally to wireless. This, as a fact, had already been tried out in 1922, when, under Lord Cavan as C.I.G.S., cable temporarily disappeared from the equipment of signal units, remaining only within the artillery and infantry formations. (*To be continued.*)

Permanent Fortification (*concluded*), by Col. Schneck. After having, in his last instalment, considered the *rôle* played by permanent fortification in each of the theatres of the Great War, the author points out considerations which must be weighed when judging the value of permanent fortifications. He sums up, "that permanent fortifications will, in future, also be necessary there is no longer any doubt. Only about the way it is to be carried out opinions differ strongly." He is quite certain, however, that the *isolated* girdle-fortress has played its part, since even the largest fortified towns can nowadays be shot to pieces by long-range artillery, supported by aerial bombardment. Against these means of attack only the widest spreading can help. Thus, in place of the girdle-fortress, and in accordance with the principles for the construction of field positions, we must have the *deep fortified* zone.

Hence, if permanent fortification is looked upon as necessary for frontier protection, or to cover the approach march in the territory of

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manœuvre, it can only be provided as a *fortified front* necessitating due provision against out-flanking.

For the design of permanent fortifications proposals differ very widely. France, in its incessant care for the protection of its frontiers, is occupied intensively with these questions. Thus, one French proposal is to have two continuous infantry lines at a distance of 500 m. apart, and 1,000–1,500 m. farther back a line of scattered *points d'appui*, equipped with the most modern means, while all further requirements are left to the period of mobilization. Another proposal advocates permanent completion, according to the principles of area-fortification—guns, m.g's, o.p's to be armoured, shelters and dug-outs to be blasted out of the rocks or built in concrete, obstacles, communications, and signal arrangements to be put in permanently. Very important is the utilization of artificial inundations or swamps as tank obstacles, and also a continuous cleared field of fire along the front. It is obvious that there is no technical impossibility about carrying out such works. It is only a question whether even a rich nation can afford the luxury of such fortification. Also the principle of economizing troops no longer holds good: all that matters is to be speedily prepared for battle.

The French Defence Proposals of Poincaré of 1927 envisage the building programme of a powerful chain of fortresses from the North Sea to the Riviera at an estimated cost of £280,000,000, to be spread over seven years, till 1935. There is proposed a deep zone consisting of many *points d'appui*, with obstacles, and including railways, broad gauge and field, detraining-stations, roads, telegraphs and telephones, aerodromes, and the building of command head-quarters and depots for R.E., Ordnance, and A.S.C. stores. On such a grand scale does France wish to defend against break-through by the enemy its thrice-barricaded Eastern frontier, "the most open and the most threatened in the whole world."

In contrast to this scheme we are given the author's own ideas. "Since it is generally possible to build quickly in the area of manœuvre positions which are capable of offering a good resistance, when good communications, ample building-material, labour, shelters, and water are present, it will be best to make certain of all these needs, to have all plans prepared, and to carry them out when the time comes, according to the latest achievements of technics." Bomb-proof dug-outs and complicated flanking arrangements are to be provided in peace as the skeleton upon which field fortifications are to be applied. It is a question, also, whether peace should provide lightly (*i.e.*, against medium artillery) armoured o.p's and m.g. posts. Excellently-built communication network is in any case a *sine qua non*.

The series of articles concludes with some notes on the application of permanent fortification to mountainous country.

F.A.I.

REVUE MILITAIRE FRANÇAISE.

(*April*, 1928).—Commandant Roques completes "*L'organisation du terrain d'opérations de Champagne pendant la guerre mondiale*" in this number. A mass of statistics referring to administrative measures,

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which had to be taken in the back areas, is given ; the interesting part of the article lies in the conclusion. The writer estimates that a modern army cannot work efficiently more than 45 miles from its organized railway system. This is a conclusive answer to those who criticized the acceptance of the Armistice in 1918, but we must not necessarily take the conclusions of 1918 as holding good for a future war with mechanized weapons.

"*Au Maroc français en* 1925. *Le rétablissement de la situation militaire*," by Capitaines Lacau and Montjean, is completed in this number. The writers deal with the training, moral and material, required to reinvigorate the French troops before their final success. Certain lessons of the Great War had to be unlearnt before the French forces became really efficient. Once the forces were modelled in the way required for warfare of this kind, brilliant and stable results were achieved in a short space of time.

"*Les débarquements de vive force*," by Colonel Alléhaut, begins in this number. The writer considers that combined operations have not been studied sufficiently in the past, and his object is to indicate the various stages of this type of operation. In this instalment he points out the two essentials of secrecy and speed, and then describes the preliminary questions which have to be considered, including the selection of the necessary advanced bases, both for sea, land and air forces. While no attempt is made to give details, the various stages are clearly set out.

Lieut.-Colonel Desmazes and Commandant Naoumovitch complete "*Les victoires serbes en* 1914," in this number. The Battle of the Koulabara, which took place during the first half of December, is described in considerable detail. The Austrians, who had advanced a long way into Serbia, and who were on the point of continuing their attacks, were driven back by a sudden counter-thrust of the Serbs, and by the middle of the month had been forced to re-cross the Sava River. This was a most brilliant operation on the part of the Serbs, as they were almost completely lacking in munitions ; unfortunately, it brought them little nearer contact with their allies, and they had to wait for nearly four years of anguish before their victory was completed.

The third instalment of Colonel Armengand's important article, "*Les enseignements de la guerre marocaine en matière d'aviation*," appears in this number. Special attention is given to the use of aircraft for bombardment in mountain warfare. The less efficient artillery becomes, the more aircraft can be used against an enemy who neither possesses an air force of its own nor efficient anti-aircraft weapons. Many interesting examples of this use of aircraft in Morocco are given ; apparently, on certain occasions, artillery fire was almost entirely replaced by fire from aeroplanes. The writer is convinced that really strong air forces are required in this type of savage warfare, and he marshals his arguments clearly and convincingly. Several excellent oblique photographs illustrate the article.

"*Les fortifications permanentes de l'Allemagne en* 1927," by C.L.L., describes briefly negotiations between the German Government and the Ambassadors' Conference since the Great War. The Peace Treaty of

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Versailles took away from Germany her Western fortresses, and it seems that now her only strong permanent defence is in East Prussia.

(*May*, 1928).—Commandant d'Argenlieu begins "*La bataille de l'Avre*," in this number. The instalment describes the opening stages of the operations at the end of March, 1918, just south of the British 5th Army. It is rather difficult to pick out the salient points from the mass of detail that is given.

"*Les enseignements de la guerre marocaine en matière d'aviation*," by Colonel Armengand, is completed. The writer's conclusions are most interesting, but whether the results of semi-civilized warfare can be applied, as completely as he thinks, to European war is open to doubt. The view is put forward that, in battle, the main task of aircraft is to join with the other arms in crushing the enemy's field forces, rather than to attack back areas, and for this purpose an air force "of the line" capable of undertaking a large number of different tasks is required. Whether the reader agrees or not with Colonel Armengand's conclusions, the article is well worthy of study.

"*La défense du Bois de Ville et de l'Herbebois*," by Lieutenant-Colonel Paquet, begins in this number. The description is of the action of the 51st Division in the German attack on Verdun in 1917, but it is of little interest to anyone who did not take part in the Battle. This instalment describes the preliminary measures; the mistake of holding the front line as the main line of defence is very obvious.

Colonel Alléhaut concludes "*Les débarquements de vive force*" in this number. A clear description of the various steps required in combined operations is given, including the formation of the "first flight," and the rest of the covering force. An interesting point is the hour to be selected; the writer favours the night, an hour or two before dawn, so as to give time for the beaches to be cleared before a dawn advance. The whole article forms a good outline description of combined operations.

"*La dernière offensive d' Abd-el-Krim*," by Général Vanbremersch, describes the Rif leader's final effort before the eventual Franco-Spanish Advance. The sketches illustrating this instalment appear in the June number, but even without following the details on the map, the account of the attack is interesting. The onslaught was a complete surprise, and various defensive posts were completely cut off. The instalment ends with the orders given to effect the relief of these posts.

(*June*, 1928).—Commandant d'Argenlieu continues "*La bataille de l'Avre*," in this number. The period up to the end of March, 1918, is described in considerable detail, during which the French were forced to fall back on the British 5th Army. Three maps are given in illustration of the operations.

"*Autour des batailles de Napoléon*," by Général Camon, is a discussion of a favourite manœuvre of the Emperor, that of holding the enemy in front while an outflanking force strikes in on his line of retreat. In this instalment the writer describes the Battle of Marengo and points out that Napoleon was unsuccessful in his efforts to direct this battle

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"according to plan." He then quotes from an account written by Napoleon at St. Helena, describing the battle as it should have been, rather than as it was, for the benefit of posterity. More successful battles of this type are to be considered in future instalments.

Général Vanbremersch concludes "*La dernière offensive d'Abd-el-Krim*" in this number. The French counter-attack on the plateau of Issoual, which had been captured by the enemy, is described. The counter-attack was successful and the captured posts were relieved; this action marked the beginning of the end for Abd-el-Krim. The writer's comments are interesting; he points out that whereas Abd-el-Krim's conception was excellent, the lack of command of his troops caused his attack only to reach a portion of the objective. Instead of masking the French posts and pushing on, the enemy wasted time in attacking them with a view to pillage. On the other hand, during the French counter-attack, threats of envelopment, directed by Commanders on the spot, were immediately successful in turning the enemy out of the positions they had gained.

In continuing "*La défense du Bois de Ville et de l'Herbebois*," Lieut.-Colonel Paquet describes the outbreak of the German attack on Verdun, on the front of the 51st Division. It is the usual description of a tremendous bombardment followed by the infantry attack, opposed by small counter-attacks which had little effect, as it was quite impossible to organize them, the German bombardment having destroyed all means of communication apart from runners and dispatch-riders.

"*Le système des récompenses dans les armées romaines*," by Capitaine Andrieux, follows a previous article by the same author, on punishments in the Roman Army. Rewards were either honorary, such as bracelets, crowns, etc., culminating in the triumph, pecuniary or actually in kind. The last consisted sometimes of extra rations issued to units who had earned the award.

H.A.J.P.

REVUE DU GÉNIE MILITAIRE.

(*March*, 1928).—The first article, by Doctors Edmund and Stephen Sergent, deals with the suppression of the anopheles mosquitoes in the neighbourhood of camps. Their method is based on the fact that in the cilmate of the Mediterranean the life of the larvæ averages three weeks in summer. Therefore, in arranging the drainage of places where water is likely to stand, two channels to be used alternately week by week should be constructed. The drying up of the channel not in use destroys all mosquito larvæ in it.

An article, by Lieut.-Colonel Grelier, called "Ten Days on the Aisne with the 14th Division," describes the part played by the engineers in the operations from September 11th till September 20th. It included the repair of the road bridge at Vic, damaged by the Germans in their retreat on September 12th, and the construction of another bridge to take motor lorries, in which barges were used as piers, the superstructure being made from material obtained locally.

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There is an interesting article, by Chef d'Escadron J. Veyrier, called "The Use for Military Purposes of Multiple Arched Dams." The advantages of the simple arched dam over the straight dam, depending on its mass for its stability, are well known. The use of reinforced concrete is responsible for the introduction of the multiple arched dam, in which the hydraulic pressure is transmitted to the sides of the valley, not by one arch only but by a series of small arches, with parallel axes supported by vertical buttresses of reinforced concrete. The subject of the article refers to an extension of this system. The principle consists in dividing the dam into a number of walls, decreasing successively in height, in the down-stream direction. Between each pair of walls the water stands on a level with the tops of the lower of the two, so that that part of each wall which is in contact with water on both sides is subjected to a pressure corresponding to the difference between the levels of the two adjacent strips of water.

Whether each wall is constructed on the simple or multiple system of arches, it can be of uniform thickness for the greater part of its height.

The writer describes how the principle can be applied for military purposes by using steel sections of fixed pattern for constructing the dams.

There is a continuation of the "Sieges of Przemysl," by Colonel Beyer.

(*April*, 1928).—"The Use of Wire Gabions filled with Stones, on the Roads in Northern Morocco," is the subject of an article by Lieut.-Colonel Puissant. The Gabions described are much the same as those used on the Indian frontier for river training and bridge protection. They were used in Northern Morocco for :

Protection of bridge piers against scour.
Protection of river banks.
Construction of a road on subaqueous foundations.
Abutments and floors of culverts.
Revetments of slopes.

There is a translation, by Colonel Beyer, from the *Militärwissenschaftliche und Technische Mitteilungen* of an account of the second investment of Przemysl.

(*May*, 1928).—A long and interesting account of "Works Carried out in Morocco by the Service des Routes de l'Armée," is given by Lieut.-Colonel Puissant.

The personnel available in that department consisted of :—

(1) A varying number of companies of engineers.
(2) Moroccan labour companies.
(3) Native civilians (organized in gangs of 20 to 50, under a headman, and paid 8 to 10 francs per diem).
(4) Occasional military working parties.
(5) Selected civilian overseers.

Tools and materials were supplied from headquarters at Fez and Taza.

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Works had to be carried out rapidly and as it was impracticable to make a regular preliminary survey, the following method was employed :—

(1) Possible routes were obtained from the map or from information.
(2) Reconnaissance was made by " clysimètre " and barometer of those which seemed the best.
(3) After discussion a line was chosen and a rapid compass survey made.
(4) The principal difficulties were examined and studied on the ground.
(5) A provisional line was marked on the ground by heaps of stones.
(6) A section was made by " clysimètre " or level.
(7) A path was constructed on that line to facilitate detailed study and sometimes by a track for the conveyance of material and rations.

Works were designed so as to reduce to a minimum the employment of artisans, who, except for masons of no great skill, were very difficult to obtain. The use of piles in river beds was avoided as far as possible. " Pigeaud " bridges were used for spans of 17½ to 37½ metres, bridges of girders and concrete for spans of 3½ to 9½ metres constructed in accordance with type designs. For spans of 1 to 3 metres, semi-circular masonry arches were used. For smaller spans tubes of not less than a half-metre diameter were used, usually old oil drums, encased in concrete.

Roads were for one line of traffic, and were 4 metres wide. Maximum gradient was 6 per cent., rarely 7 per cent. for short distances.

Several large bridges were constructed and about 165 miles of metalled roads between various places.

The writer gives an interesting account of these works, with plans of some of the bridges and a map.

Colonel Tricand contributes an article in which he describes a graphic system for finding the charges for mines to form road craters.

There is a continuation of the translation of " The Second Investment of Przemysl."

A.H.B.

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CORRESPONDENCE.

WIRE-NETTING ROADS.

THE following correspondence on the subject of the origin of wire-netting roads, part of which has already appeared in the April, 1928, *Supplement to the R.E. Journal*, is now published in the *Journal* itself, as being of general interest.—[EDITOR].

Manchester Corporation Tramways,
General Offices: 55, Piccadilly,
Manchester.
15th March, 1928.

SIR,

My attention has been drawn to a paragraph in the *Daily News and Westminster Gazette* that you were endeavouring to trace the origin of the wire roads in the Sinai desert.

I made numerous enquiries myself whilst there, but was unable to locate the individual to whom the credit may be due. The history, however, I understand to be as follows:—

A quartermaster-sergeant at Kantara noticed how easily he could walk on the sand when wire netting was spread out, being cut to lengths for service. With the usual quartermaster-sergeant's longing for comfort, he laid a stretch of such wire between his tent and the stores. This was noticed by an R.E. officer, and by him subjected to sufficient trial, the outcome of which was, as is well known, the miles of excellent roadway.

I have pleasure in submitting this information for what it may be worth.

I have the honour to be, Sir,
Yours faithfully,
HENRY MATTINSON, *late Major, R.E.*

To Brigadier-General J. E. Edmonds, C.B., C.M.G.,
O. i/c Military Branch, Historical Section,
Committee of Imperial Defence,
2, Whitehall Gardens, S.W.1.

British Legation,
Santiago,
Chile.
2nd May, 1928.

The Editor, *The Royal Engineers Journal.*

DEAR SIR,

The reply to Major Mattinson's enquiry in the April *Supplement* is that the wire roads were *evolved*, not *invented*; and that the place of their evolution was not Sinai.

It happened in this wise.

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In about the month of November, 1915, the Command in Egypt had to take measures to counter the threatened invasion of the Nile valley by the Senussi Arabs of the West. Amongst the measures was the location of a strong detached post covering the little oasis of El Moghara, some 90 miles south-west of Alexandria, and some 30 miles south of the station on the Alexandria-Dabaa railway from which the garrison was supplied by motor convoy.

This motor convoy, finding the surface of the desert track cutting up badly under the wheels of their Ford cars, laid down rushes obtained from the oasis on the worst patches.

For some days all was well! Then arose a gale, which removed the carefully laid rushes, and repeated the process at frequent intervals, until the rushes in one particularly bad short stretch of track were anchored down with strips of wire netting diverted surreptitiously from some more orthodox use. All was well again!

But the war went on, and the sun beat down and dried up the rushes under the wire, so that they eventually disappeared completely under the grinding of many Ford wheels. Strange to relate, all was still well! Wheels, and, still more so, ammunition boots, continued to pass lightly over the surface of the sand, with only the netting in between!

Thus was a great invention "evolved." It soon became customary for cars doing desert patrols to carry wire instead of planks to help them through soft places.

Thus far I claim to speak with the authority of personal knowledge, having been G.S.O.1 of the W.F.F. at the time. Should confirmation be needed, it can doubtless be found amongst the records of the Pembroke and Montgomery Yeomanry, who (dismounted) formed the garrison of Moghara post under the command of Lieut.-Colonel (late Brigadier-General) Lloyd.

At a later date, when *liaison* measures commenced to span the wide gulf hitherto fixed between the small and unfashionable Western Frontier Force of the Libyan desert and the Mediterranean (later Egyptian) Expeditionary Force, then on the Suez Canal (which forces owed allegiance to different members of the trinity of High Commands who directed military affairs in the Near East), apostles were dispatched by the W.F.F. to impart the results of their desert experience to the E.E.F.

I am not certain which of the apostles was definitely charged with extolling the virtues of the wire road, but strongly suspect a "light car patrol," which demonstrated at Ismailia and Kantara various aids to getting a Ford car over the desert, including the water condenser, the sun compass, and the use of wire netting.

Another somewhat similar point which appears to have given rise to uncertainty is the authorship of the Suez Canal inundations. The authentic author is much too modest to settle the matter himself, but will, I hope, forgive me for disclosing his name in an endeavour to prevent the credit being given to yet more persons, only *some* of whom have disavowed it. It was Colonel (afterwards Major-General) H. B. H. Wright (R.E.), my very-respected chief during much of the War, who planned and ordered the execution of these inundations.

In consultation with Sir William Willcox (the irrigation engineer and

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antiquary), and with the Suez Canal authorities, he decided to admit the salt water of the Canal into the ancient river-bed and swamps of the old Pelusiac branch of the Nile, whose course intersects the canal, but which has been dried up and largely obliterated by sand since many centuries before the Christian era.

The necessary cuts were made in November, 1914, and the resulting inundations covered three-fourths of the distance between Port Said and Kantara, thereby shortening, permanently and at negligible cost, the defence line by some 25 miles.

Yours very truly,

R. E. M. RUSSELL, *Colonel.*

SCIENTIFIC SOLDIERSHIP.

The Editor, *The R.E. Journal.*

SIR,

The claim of the exponents of " Mechanized " warfare, and particularly of the protagonists of armour, that the development of the tank will necessarily lead to a reversion to mobile warfare is of more than ordinary interest to those members of the Corps who are, like myself, " Specialists" in Survey.

If this claim is substantiated, it must entail very sweeping changes in present survey policy, and many of the survey methods evolved during the Great War, particularly those connected with Artillery, will have to be scrapped altogether.

These methods proved their value in France, and we now spend not a little time and trouble in training officers and men in their use ; but they refer only to indirect fire, and would have no place in the sort of warfare envisaged by the tank " experts."

It is not, therefore, in any captious spirit that I ask you to allow me to put a few questions through the medium of your pages, to the distinguished author of " Scientific Soldiership."

He tells us that " infantry are likely to disappear because they cannot protect themselves against armoured machines " ; does he not mean " infantry as at present armed " ? For is it not true that the foot soldier, *appropriately armed*, can defend himself quite easily against such machines ? The trouble is, surely, that the weapons he requires for this purpose will not defend him against other infantry.

If our possible adversaries agree with Colonel Fuller that it is " better to replace existing arms by tanks," it would be necessary for us to change our " infantry armaments," for no one but a lunatic would try to attack a tank with a bayonet, but it is reasonable to ask Colonel Fuller to explain why this is impossible before his claim that only " tank can attack tank " will be admitted.

He contends that " it was the bullet on the defensive which rendered the war static," and that the " obvious answer was armour plate." As the bullet has been on the defensive many times before 1914 without rendering war static, I venture with all diffidence to challenge both these

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assertions, and to ascribe the static nature of the War to the following two causes.

(1). The inability of the attack to establish that superiority of fire over the defence which our *F.S.R.* correctly told us was an essential prelude to movement in the immediate vicinity of the enemy.

(2). The ability of both sides to form a continuous defensive line between impassable flanks.

I suggest, then, that the obvious answer to the " bullet on the defensive " is still, as it has long been, not armour but another bullet, aimed straighter and carrying further.

Colonel Fuller will doubtless agree that the very core of the " unchanging framework of tactics "is the establishment of a moral ascendancy over one's enemies, and that the quickest and surest way of achieving this is by using one's weapons more vigorously and more successfully than they are able to do.

No soldier, scientific or other, will contend that armour is a weapon, or that it is possible to establish a moral ascendancy over anyone by hiding behind it.

In fact, at the risk of being called unscientific, I must confess that it seems to me that those who persist in carrying armour plate about them wherever they go, and hiding behind it whenever they come in contact with the enemy, are handicapping themselves by imposing serious and unnecessary limitations on their freedom of movement.

Other things being equal, *i.e.*, with equal power available on both sides, that combatant who carries the least armour will be the most mobile, or with equal mobility will be able to carry the heaviest guns.

How, then, can Colonel Fuller maintain that " the tanks (*i.e.*, the armour carriers) can stand off outside their effective range (*i.e.*, of the unarmoured forces) and bring heavy fire to bear . . ."

Surely the boot will be on the other leg.

Equally, how can they " ignore infantry and guns, and move still further in rear and attack the supply services ? "

Is it not more likely that these venturesome machines will be hard put to it to protect their own laagers against troops in more mobile vehicles who rely on guns rather than armour for their defence ?

Perhaps I am " prejudiced in favour of particular weapons," but I must say that it seems to me that Colonel Fuller is confusing the tactical attributes of armour and mobility, and is endowing the one with the virtues of the other. If it be true that he has fallen into this curious error, it must follow that his " area theory " and other deductions will require considerable amendment.

I am, etc.,

M. N. MACLEOD.

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LANDING AT SUVLA. 6TH TO 15TH AUGUST, 1915.

Unit.	Formation.		Remarks.
R.E. Div. units of 2nd Aust. Div.	2nd Aust. Div.	N.E.	
R.E. Div. units of R.N. Div.	R.N. Div.	,,	
IX Corps Signal Co.	IX Corps	E.	No unit diary. Presumptive evidence.
133rd Fortress Co.	L. of C.	,,	
Australian Bridging Train	,,	,,	

SCIMITAR HILL, 21ST AUGUST, 1915.

Unit.	Formation.		Remarks.
65th Field Co.	10th Div.	E	
66th ,,	,,	,,	
85th ,,	,,	,,	
10th Div. Sig. Co.	,,	,,	No unit diary. Presumptive evidence.
67th ,,	11th Div.	,,	
68th ,,	,,	,,	
86th ,,	,,	,,	
11th Div. Sig. Co.	,,	,,	No unit diary. Presumptive evidence.
71st Field Co.	13th Div.	N.E.	
72nd ,,	,,	,,	
88th ,,	,,	,,	
13th Div. Sig. Co.	,,	,,	
1/2nd London Field Co.	29th Div.	E.	
1/2nd Lowland Field Co.	,,	,,	
1/1st W. Riding Field Co.	,,	,,	
29th Div. Sig. Co.	,,	,,	No unit diary. Presumptive evidence.
R.E. Div. units of 42nd Div.	42nd Div.	N.E.	
R.E. Div. units of 52nd Div.	52nd Div.	,,	
1/1st Welsh Field Co.	53rd Div.	E.	
2/1st ,,	,,	,,	No unit diary. Presumptive evidence.
2/1st Cheshire Field Co.	,,	,,	
53rd Div. Sig. Co.	,,	,,	
1/2nd E. Anglian Field Co.	54th Div	,,	
2/1st ,,	,,	,,	No unit diary. Presumptive evidence.
54th E. Anglian Div. Sig. Co.	,,	,,	
1st Aust. Field Co.	1st Aust. Div.	N.E.	
2nd ,,	,,	,,	
3rd ,,	,,	,,	
1st Aust. Div. Sig. Co.	,,	,,	
1st N.Z. Field Co.	N.Z. and A. Div.	,,	
2nd ,,	,,	,,	
1st N.Z. Field Troop	,,	,,	
A. & N.Z. Div. Sig. Co.	,,	,,	
R.E. units of 2nd Aust. Div.	2nd Aust. Div.	,,	
R.E. units of R.N. Div.	R.N. Div.	,,	
IX Corps Sig. Co.	IX Corps	E.	No unit diary. Presumptive evidence.
133rd Fortress Co.	L. of C.	,,	
Australian Bridging Train	,,	,,	

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GALLIPOLI. 25TH APRIL, 1915, TO 8TH JANUARY, 1916.

Unit.	Formation.		Remarks.
All units E for			
"Helles"		E.	
"Landing at Helles"		,,	
"Krithia"		,,	
"Anzac"		,,	
"Landing at Anzac"		,,	
"Defence of Anzac"		,,	
"Suvla"		,,	
"Landing at Suvla"		,,	
"Scimitar Hill"		,,	
"Sari Bair"		,,	
and in addition,			
3rd R.N. Div. Field Co.	R.N. Div.	,,	
1/1st Kent Field Co.	L. of C. (Mounted Div.)	,,	
1/2nd ,,	,,	,,	
4th Aust. Field Co.	2nd Aust. Div.	,,	
5th ,, (later numbered 8th Aust. Field Co.)	,,	,,	
2nd Aust. Div. Sig. Co.	,,	,,	
37th Fortress Co.	L. of C.	,,	
No. 5 Siege Co. R. Monmouth R.E.	,,	,,	
136th Fortress Co.	,,	,,	
134th ,,	,,	,,	
VIII Corps Sig. Co.	VIII Corps	,,	
M. (L. of C.) Sig. Co.	G.H.Q.	,,	Detachments on the Peninsular.
14th Fortress Co.	L. of C.	D.	
1/3rd Devon Fortress Co.	,,	,,	
Anglesey Siege Co.	,,	,,	
117th Railway Co.	,,	,,	
13th Base Park Co.	,,	,,	
46th ,,	,,	,,	
Mounted Div. Sig. Sqdrn.	Mounted Div.	,,	The diaries of units and also of higher formations are missing in a great many cases. It has been extremely difficult to compile lists of eligibility and the completeness and accuracy of the lists is doubtful.

EGYPT.

SUEZ CANAL. 3RD TO 4TH FEBRUARY, 1915.

Unit.	Formation.		Remarks.
1st E. Lancs. Field Co.	42nd (E. Lancs.) Div.	E.	Attached 22nd Indian Inf. Bde.
No. 10 Co. Q.VO. S. & M..	11th Indian Div.	E.	

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RUMANI. 4TH TO 5TH AUGUST, 1916.

Unit.	Formation.		Remarks.
1/1st E. Lancs. Field Co.	42nd (E. Lanc.) Div.	E.	
1/2nd ,,	,,	,,	
1/3rd ,,	,,	,,	
2/1st Lowland Field Co.	52nd (Lowland) Div.	,,	
1/2nd ,,	,,	,,	
2/2nd ,,	,,	,,	
1/1st Welsh Field Co.	53rd Div.	N.E.	
2/1st ,,	,,	,,	
2/1st Cheshire Field Co.	,,	,,	
2/1st E. Ang. Field Co.	54th Div.	,,	
1/2nd ,,	,,	,,	
1/1st Kent Field Co.	,,	,,	
No. 7 Field Troop	Canal Defences	E.	
No. 9 ,,	,,	N.E.	
1st Aust. Field Sqdrn.	,,	D.	
14th Army Troops Co.	,,	N.E.	
220th ,,	,,	D.	
No. 5 Siege Co. R.M. R.E.	,,	,,	

SIGNALS.

RUMANI. 4TH TO 5TH AUGUST, 1916.

Unit.	Formation.		Remarks.
42nd Div. Signal Co.	42nd Div.	E.	
52nd ,,	52nd ,,	,,	
53rd ,,	53rd ,,	N.E.	
54th ,,	54th ,,	,,	

RAFAH. 9TH JANUARY, 1917.

Unit.	Formation.		Remarks.
1st Aust. Field Sqdrn.	A. & N.Z. Mtd. Div.	E.	
No. 7 Field Troop	5th Mtd. Bde.	D.	No diary.
No. 10 Co. Q.V.O. S. & M.	Desert Column.	N.E.	
2/1st Cheshire Field Co.	53rd Div.	E.	Attached A. & N.Z. Mtd. Div.
1/1st E. Lancs. Field Co.	42nd Div.	N.E.	
1/2nd ,,	,,	,,	
1/3rd ,,	,,	,,	
2/1st Lowland Field Co.	52nd Div.	,,	
1/2nd ,,	,,	,,	
2/2nd ,,	,,	,,	

SIGNALS.

RAFAH. 9TH JANUARY, 1917.

Unit.	Formation.		Remarks.
W Corps Signal Co.	Desert Column	N.E.	
1st A. & N.Z. Sig. Sqdrn.	Anzac Mtd. Div.	E.	
5th Mtd. Bde. Sig. Troop	Desert Column	D.	
42nd Div. Sig. Co.	,,	N.E.	No diary.
52nd ,,	,,	,,	No diary.

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PALESTINE.

GAZA. 26TH TO 27TH MARCH, 1917. 17TH TO 19TH APRIL, 1917. 27TH OCTOBER TO 7TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
XX CORPS.			
65th Field Co.	10th Div.	E.	
66th ,,	,,	,,	
85th ,,	,,	,,	
436th (Welch) Field Co.	53rd Div.	,,	
437th ,,	,,	,,	
439th (Cheshire) Field Co.	,,	,,	
519th (London) Field Co.	60th Div.	,,	
521st ,,	,,	,,	
522nd ,,	,,	,,	
No. 5 Field Co. R.M.R.E.	74th Div.	,,	
No. 5 Field Co. R.A.R.E.	,,	,,	
XXI CORPS.			
410th (Lowland) Field Co.	52nd Div.	,,	
412th ,,	,,	,,	
413th ,,	,,	,,	
484th (E. Ang.) Field Co.	54th Div.	,,	
486th ,,	,,	,,	
495th (Kent) Field Co.	75th Div.	,,	
496th ,,	,,	,,	
DESERT MOUNTED CORPS.			
No. 8 Field Troop	7th Mtd. Bde.	,,	No diary.
No. 10 ,,	Imp. Camel Corps Bde.	,,	
No. 4 Aust. Field Troop	Desert Mtd. Cps.	,,	No diary.
1st Aust. Field Sqdrn.	Anzac Mtd. Div.	,,	
2nd ,,	Aust. Mtd. Div.	,,	
No. 6 Field Sqdrn.	Yeomanry Mtd. Div.	,,	
ARMY TROOPS.			
14th Army Troops Co.	XXI Corps	E.	
35th ,,	G.H.Q.	N.E.	
220th ,,	XX Corps	E.	
No. 10 Fd. Co. 2nd Q.V.O.	L. of C.D.	E.	
115th Railway Co.	G.H.Q.	,,	
116th ,,	,,	,,	
265th ,,	,,	,,	
266th ,,	,,	,,	
359th Co. R.E. (Water Unit)	L. of C.	N.E.	
360th ,,	,,	,,	
555th (Lancs.) Army Troops Co.	,,	D.	No diary.
569th (Devon) ,,	,,	N.E.	
570th (Devon) ,,	,,	,,	
571st Army Troops Co.	,,	,,	

SIGNALS.

GAZA. 26TH TO 27TH MARCH, 1917. 17TH TO 19TH APRIL, 1917. 27TH OCTOBER TO 7TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
V Corps Signal Co.	XX Corps	E.	
10th Div. Signal Co.	10th Div.	,,	
53rd ,,	53rd ,,	,,	
60th ,,	60th ,,	,,	
74th ,,	74th ,,	,,	
U Corps Signal Co.	XXI Corps	D.	

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SIGNALS.

GAZA. 26TH TO 27TH MARCH, 1917. 17TH TO 19TH APRIL, 1917. 27TH OCTOBER TO 7TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
52nd Div. Signal Co.	52nd Div.	E.	
54th ,,	54th ,,	,,	
75th ,,	75th ,,	,,	
W Corps Signal Co.	Desert Mtd. Corps	,,	No diary.
Bde. Signal Section	7th Mtd. Bde.	,,	No diary.
,,	Imp. Camel Corps Bde.	,,	
1st Aust. Signal Sqdrn.	Anzac Mtd. Div.	,,	
2nd ,,	Aust. Mtd. Div.	,,	
Yeomanry Mtd. Div. Sig. Sqdrn.	Yeomanry Mtd. Div.	,,	

EL MUGHAR. 13TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
XX CORPS.			
436th (Welsh) Field Co.	53rd Div.	E.	
437th ,,	,,	,,	
439th (Cheshire) Field Co.	,,	,,	
519th (London) Field Co.	60th Div.	,,	
521st ,,	,,	,,	
522nd ,,	,,	,,	
XXI CORPS.			
410th (Lowland) Field Co.	52nd Div.	,,	
412th ,,	,,	,,	
413th ,,	,,	,,	
484th (E. Ang.) Field Co.	54th Div.	,,	
486th ,,	,,	,,	
495th (Kent) Field Co.	75th Div.	,,	
496th ,,	,,	,,	
DESERT MOUNTED CORPS.			
4th Aust. Field Troop	C.H.Q.	,,	
No. 8 Field Troop	7th Mtd. Bde.	,,	
No. 10 ,,	Imp. Camel Corps Bde.	,,	
1st Aust. Field Sqdrn.	Anzac Mtd. Div.	,,	
2nd Aust. ,,	Aust. Mtd. Div.	,,	
No. 6 Field Sqdrn.	Yeomanry Mtd. Div.	,,	
ARMY TROOPS.			
14th Army Troops Co.	XXI Corps	E.	
35th ,,	G.H.Q.	N.E.	
220th ,,	XX Corps	,,	
No. 10 Co. 2nd S. and M.	L. of C.D.	,,	

SIGNALS.

EL MUGHAR. 13TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
V Corps Signal Co.	XX Corps	D.	
53rd Div. Signal Co.	53rd Div.	E.	
60th ,,	60th Div.	,,	
U Corps Signal Co.	XXI Corps	,,	

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SIGNALS.

EL MUGHAR. 13TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
52nd Div. Signal Co.	52nd Div.	E.	
54th ,,	54th Div.	,,	
75th ,,	75th Div.	,,	
W Corps Signal Co.	Desert Mtd. Cps.	,,	No diary.
Bde Signal Sec.	7th Mtd. Bde.	,,	No diary.
,,	Imp. Camel Corps Bde.	,,	No diary.
1st Aust. Signal Sqdrn.	Anzac Mtd. Div.	,,	
2nd ,,	Aust. Mtd. Div.	,,	
Yeomanry Mtd. Div. Sig. Sqdrn.	Yeomanry Mtd. Div.	,,	

NEBI SAMWIL. 17TH TO 24TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
XXI CORPS.			
410th (Lowland) Field Co.	52nd Div.	E.	
412th ,,	,,	,,	
413th ,,	,,	,,	
484th (E. Ang.) Field Co.	54th Div.	,,	
486th ,,	,,	,,	
495th (Kent) Field Co.	75th Div.	,,	
496th ,,	,,	,,	
519th (London) Field Co.	60th Div.	,,	
521st ,,	,,	,,	
522nd ,,	,,	,,	
DESERT MTD. CORPS.			
4th Aust. Field Troop	C.H.Q.	,,	
No. 8 Field Troop	7th Mtd. Bde.	,,	
No. 10 ,,	Imp. Camel Corps Bde.	,,	
1st Aust. Field Sqdrn.	Anzac Mtd. Div.	,,	
2nd ,,	Aust. Mtd. Div.	,,	
No. 6 Field Sqdrn.	Yeomanry Mtd. Div.	,,	
ARMY TROOPS.			
14th Army Troops Co.	XXI Corps	,,	
220th ,,	XX Corps	N.E.	

SIGNALS.

NEBI SAMWIL. 17TH TO 24TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
U Corps Signal Co.	XXI Corps	E.	
52nd Div. Signal Co.	,,	,,	
54th ,,	,,	,,	
75th ,,	,,	,,	
60th ,,	,,	,,	
W Corps Signal Co.	Desert Mtd. Cps.	,,	
Bde. Signal Sec.	7th Mtd. Bde.	,,	
,,	Imp. Camel Corps Bde.	,,	
1st Aust. Signal Sqdrn.	Anzac Mtd. Div.	,,	
2nd ,,	Aust. Mtd. Div.	,,	
Yeomanry Mtd. Div. Sig. Sqdrn.	Yeomanry Mtd. Div.	,,	

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JERUSALEM. 7TH TO 9TH AND 26TH TO 30TH DECEMBER, 1917.

Unit.	Formation.	Remarks.
XX CORPS.		
65th Field Co.	10th Div.	E.
66th ,,	,,	,,
85th ,,	,,	,,
436th (Welsh) Field Co.	53rd Div.	,,
437th ,,	,,	,,
439th (Cheshire) Field Co.	,,	,,
519th (London) Field Co.	60th Div.	,,
521st ,,	,,	,,
522nd ,,	,,	,,
No. 5 Field Co. R.M.R.E.	74th Div.	,,
No. 5 Field Co. R.A.R.E.	,,	,,
XXI CORPS.		
484th (E. Ang.) Field Co.	54th Div.	,,
486th ,,	,,	,,
495th (Kent) Field Co.	75th Div.	,,
496th ,,	,,	,,
No. 10 Co. 2nd Q.V.O. S. and M.	,,	,,
DESERT MOUNTED CORPS.		
2nd Aust. Field Sqdrn.	Aust. Mtd. Div.	,,
ARMY TROOPS.		
14th Army Troops Co.	XXI Corps	,,
220th ,,	XX Corps	,,

SIGNALS.

JERUSALEM. 7TH TO 9TH AND 26TH TO 30TH DECEMBER, 1917.

Unit.	Formation.	Remarks.
V Corps Signal Co.	XX Corps	E.
10th Div. Signal Co.	,,	,,
53rd ,,	,,	,,
60th ,,	,,	,,
74th ,,	,,	,,
U Corps Signal Co.	XXI Corps	N.E.
54th Div. Signal Co.	,,	,,
75th ,,	,,	,,
W Corps Signal Co.	Desert Mtd. Cps.	N.E.
2nd Aust. Signal Sqdrn.	Aust. Mtd. Div.	E.

JAFFA. 21ST TO 22ND DECEMBER, 1917.

Unit.	Formation.	Remarks.
XXI CORPS.		
410th (Lowland) Field Co.	52nd Div.	E.
412th ,,	,,	,,
413th ,,	,,	,,
484th (E. Ang.) Field Co.	54th Div.	,,
486th ,,	,,	D.
14th Army Troops Co.	XXI Corps	,,

SIGNALS.

JAFFA. 21ST TO 22ND DECEMBER, 1917.

Unit.	Formation.	Remarks.
U Corps Signal Co.	XXI Corps	N.E.
52nd Div. Signal Co.	,,	E.
54th ,,	,,	,,

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PROFESSIONAL NOTES.

GOVERNMENT BUILDING RESEARCH STATION.

First Report of the Building Research Board for period ending 31st December, 1926, together with Notes on the causes of decay in brick and stone work due to the destructive action of the weather.

A SHORT history of the origin and activities of the Board is given in the Report, followed by the policy now governing investigation. These were outlined in the March number of *The Royal Engineers Journal*. It must be explained that investigation into metals is being made by another branch of the Department of Scientific and Industrial Research, and is not included in the purview of this Report.

In order to develop a Science of Building, it is suggested that the programme of work should be formed round a fundamental classification of building materials. They can be considered as falling roughly into three groups, *i.e.* :

(1) Materials in the form of crystalline aggregations (granites, marble).

(2) Materials in an amorphous state (glasses, slags) ; these are more or less unstable, and will, if opportunity arises, tend to become crystalline.

(3) Materials in a quasi-solid (colloidal) state, (timber, cements, glue) : the properties of this class depend upon the amount of water in association, thus, " when a dry specimen absorbs water there is an expansion, a loss of strength and a change in the stress-strain relationship." It would seem that there should be " co-efficients which will directly express the relationship between the physical properties of the material and its moisture content." This idea is being worked out by the Board.

One of the most important problems, however, which are engrossing the attention of the Staff, is that of the resistance of building materials to the destructive effect of exposure to the atmosphere and the weather. What opposition can they make, and how can it best be augmented ? The Building Research Station is carrying out experiments to investigate the mechanism of weathering, and to devise quick tests for resistance.

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There are many recognized causes of the decay of the stonework and brickwork in buildings, such as :

(i) erosion by the wind, assisted by dust particles ;
(ii) movement due to change of moisture content and/or temperature ;
(iii) expansive action of frost on water held in the pores of the material ;
(iv) attack by bacteria ;
(v) chemical solvent action ;
(vi) the slow crystallization of salts held in solution by acids in the water retained in the voids of the material.

The Stone Preservation Committee of the Building Research Board has been busy with tests and research in this subject for some time ; it has now been " merged into the Standing Chemical and Weathering Committee."

Of the causes of weathering mentioned above, wind erosion is not considered amongst the most serious.

Research is proceeding with movements brought about by changes of temperature and moisture content : a rising temperature may produce an expansion, while the drying out due to that rise may induce a contraction, though there must be a lag in the induced effect, and this would probably be even more marked when the temperature of the specimen is being lowered. For instance, in the case of cements the hydration products are in the form of gels, and " the amount of water associated with these gels, if given time, adjusts itself to the surrounding humidity conditions." Conversely, any unhydrated particles of the clinker " may react with surplus water long after the mass has set." The cracking of neat cement is due to the shrinking movement that takes place when it hardens in the atmosphere, and the amount of shrinkage depends upon the amount of water in the mix. When sand is added, the shrinkage takes place round the inert particles, and these minute movements are not, as it were, added up into one large crack, but are so disconnected as not to signify. The inert particles, assisted by the tiny air pockets in the mix, tend to reduce the rate of evaporation of the moisture, and consequently to reduce the sum of the strains imposed around them, and prevent serious cracking. The great importance of reliable data as to the formation and existence of cracks in cement, lies in the fact that they are the primary causes of weathering of this material : " if water cannot get in, then soluble salts cannot be washed out, nor can the embedded steel be attacked. When water does get in and wash out salts which can crystallize in the cracks, forces are introduced which cause the cracks to widen, often exposing unhydrated particles of clinker, which then hydrate, causing further straining." It has been found that " in most cases the trouble has been due to insuffi-

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cient care in the use of mixing water." Research bears out the essential value of a dry mix, because it reduces the resultant strains caused by moisture movement and the initial formation of shrinkage cracks.

Speaking generally, the effect of frost action on building material in this country is not thought to cause as much damage as other agencies; this unavoidable affliction is, however, being pressed to yield its secret.

Experiments show that "bacteria can penetrate stone at the surface, which is exposed to air, but that, in the majority of cases, penetration does not extend beyond an inch below the surface." But though "bacterial fluid suspension in contact with the polished surface of marble will effect an erosion of the surface demonstrable in so short a time as three weeks," and though "fungoid growths and lichens have been known to attack the surface of glass," the investigations into this branch of the science are still in the initial stages. But although chemical solvent action does take place, by far the most potent cause of decay, under modern conditions of smoke-laden air, is the last agency mentioned on the list, namely, crystallization such as would be caused by the conversion of calcium carbonate into calcium sulphate by sulphur dioxide when in the presence of water. This corrosive action is caused by small quantities of sulphuric acid, and also sulphurous acid and ammonium sulphate, when dissolved in rain water as it passes through our polluted atmosphere.

A type of the mechanical action which takes place is as follows:—rain, while falling through the smoky atmosphere, dissolves a certain amount of sulphuric acid: it falls on the surface of limestone, and is absorbed into the external pores to a depth of about a quarter of an inch. A slow chemical change then begins to take place, converting the calcium carbonate into calcium sulphate. In due course, when the water is evaporated out of the surface pores, the calcium sulphate crystallizes just below the surface of the stone; in crystallizing it suddenly expands, like water congealing into ice, with the result that the surface layer of the stone is eventually flaked off, and falls, leaving a pocket, into which more contaminated rain-water may soak during the next shower. The crystals of calcium sulphate may be seen in little white clusters on the freshly broken surface. These crystals seem to grow in families, and it is the persistent collection of fresh growths, each adding its little outward pressure, that ultimately pushes off the flake of stone. Magnesium sulphate has the same effect in the case of sandstones and is the cause of a great deal of the damage to the fine exterior decorations of the Houses of Parliament.

In some cases, the destruction seems to have begun a long time ago, then to have ceased for a period, and then to have begun again. This appears to be the result of re-infection from new mortar used in repairs to the old work. The fresh decay is attributable to a local increase of

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calcium sulphate, caused by any excess of lime in the new mortar being washed into the neighbouring stone, or drawn there by capillary attraction, and later being converted into the destructive $CaSO_4$ crystals. In like manner, decay in brickwork is generally caused by infection from the mortar in contact with it.

The path taken by invading liquids is being traced by means of coloured resins. Sections of the material, at varying depths from the surface, show the process of decay at work, including both the solution of the material in the solvent as well as the formation of the hostile sulphates. The key to the trouble seems to lie in the flow of this solution: "if evaporation takes place more readily from one portion of a surface than from another, a flow of the solution will take place towards that portion, and the crystallization will be there more pronounced." For this reason old mortar in walls, being very porous, offers the easiest surface for evaporation, and is often found to become loosened and fall out. But when, as a result, that porous mortar is replaced with a denser cement, the flow is reversed, and the consequent crystallization takes place in the brick or stone near the new cement joint. The reason is that "the salts which give trouble sometimes come from the mortar itself. Free lime is usually present, which water can dissolve and transmit to the structure; this lime, when acted upon by atmospheric acids, frequently causes efflorescence, and sometimes decay. Even with Portland cement, this trouble may occur, as lime is set free on hydration of the cement."

"The remedy suggested is the use of a pozzolana. A substance may be called pozzolanic when, while not necessarily cementitious by itself, it possesses constituents which will combine with hydrated lime at ordinary temperatures in the presence of moisture to form stable insoluble compounds of cementitious value."

Pozzolanas are used far more on the Continent than in this country. They were also in general use at the beginning of the Christian era.

When the writer was excavating the foundations of the old Roman fort near Alexandria in Egypt, it was most noticeable that the lime mortar joints were often stronger than the bricks or tiles of the structure, and that, if a mass of the material were fractured, the break would occur across the aggregate rather than along the mortar joints. The secret has been found to lie in the successful use of a pozzolana in conjunction with properly slaked lime.

It is possible to-day to obtain a lime-pozzolana mixture, which will vie with any of these old mortars in strength and endurance: the long-hidden secret being the neutralization of free lime, which is then unable to combine with sulphur and other impurities to form destructive crystals. A stable insoluble compound of adhesive property is formed instead.

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Naturally, for economical reasons, this pozzolana should be produced locally, either from a natural or an artificial source.

These sources can roughly be classified as under :—

Natural pozzolanas, such as :

Italian pozzolanas.
Santorin earth (Greek).
Trass (Rhine and Bavaria).
Volcanic ash deposits (S.E. France, Azores, Canaries, Japan).
Diatomaceous earth (Scotland, Ireland, U.S.A., etc.).

Artificial pozzolanas, such as :

Granulated blast-furnace slag.
Crushed bricks and tiles of certain kinds.
Burnt " surkhi " or Indian clay.
Furnace clinker.
" Si-stoff," or residues from continental alum manufacture.

Dual type pozzolana, such as :

Gaize, a natural silicious material from the Ardennes. Spent oil-shale has also yielded results that appear to be promising : this source is being investigated.

The natural pozzolanas are mostly of volcanic origin.

There is a British Standard Specification (No. 146—1926) for Portland blast-furnace cement.

Clay products lose their pozzolanic activity if burnt at too high a temperature, and certain clays are unsuitable. If clay has to be excavated in any quantity on the site of works, the possibility of producing a good pozzolana for future constructional purposes would amply repay experiments in burning. A pozzolana should be ground no less finely than ordinary Portland cement.

The actual effect of the pozzolana is to combine with the lime to form insoluble silicates and aluminates : the mortar can then set and acquire hardness even under water or in such damp positions as the centre of a mass of masonry, where pure lime mortar might not set satisfactorily. It is said by Continental engineers that Portland cement concrete would not appreciably lose strength if 30 per cent. of the cement were replaced by trass ; on the other hand, its impermeability to fresh or sea water is markedly improved : " also the resistance of Portland cement to injury by severe heating can be materially increased by pozzolanic addition."

Further information on the use of pozzolanas can be obtained from *Building Research Bulletin* No. 2.

In connection with this research work of the Building Research Board, it may be of interest to know that experiments into the causes and possible cure of the destructive effect of weathering on

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building materials are also being separately carried on by other investigators.

Professor Laurie, M.A., B.SC., has also been conducting careful and extensive tests and observations all over Great Britain, with the view of finding the causes and most suitable cures for this profitless destruction, which is wasting some hundred thousands a year.

He has found that, if a piece of sandstone is soaked in a salt solution, and then covered on all its faces but one with vaseline, and if that one free face be alternately wetted and dried, fresh salt will keep on crystallizing out of this face. This experiment sounds obvious, but when considered and acted upon, it has a very important result. The vaselined faces may be regarded as the stone surfaces which are bedded into a building, leaving one surface free to the weather. By alternate spraying and drying, fresh crystals can be made to form on the exposed face, and subsequently removed by the washing. This process can be continued till the stone is washed free of salt.

Experiments on a variety of limestones also showed that they can be washed free of the deleterious salts. The face of a calcareous stone in the neighbourhood of London was washed out in like manner with a watering can on four successive days : the subsequent analyses showed the removal of a considerable percentage of calcium sulphate. In another experiment he covered the only free face of a saturated stone with Portland cement, and then carried out the alternate spraying and drying as before. But this time the crystallization took place behind the cement covering, which was finally detached, disclosing a film of rotted stone below the crystals.

Professor Laurie's own deductions are that " this is due to the fact that, owing to the alteration of surface tension on concentration for most salt solutions, if the capillaries have only one surface of evaporation, the solution is drawn out of the capillaries to that surface, and the salts deposited there. The rain brings with it sulphurous and sulphuric acids and ammonium sulphate, all of which attack calcium carbonate, but at the same time the rain is dissolving out the calcium sulphate, and so tending to prevent crystallization inside the stone. For this to be effective, a stone is required in which the evaporation is rapid." For in that case a balance is set up between the accumulation by chemical action and the removal by washing out of the calcium sulphate or other deleterious salt. He found this deduction borne out in regard to the parapet of Ketton stone outside Westminster Hall, and the stone in some parts of Lincoln Cathedral. The aggregate decay has been practically brought to a standstill in the cases of these stones of high capillary power. In an experiment carried out on four limestones it was found that Portland stone gave the best results in rate of absorbing water and drying out. Perhaps this is why it resists London's atmospheric conditions better than any other stone.

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Sulphur dioxide can be carried over long distances in the air, as is proved by the weathering at Ely Cathedral and Tintern Abbey, both far from centres of population and the resultant smoke.

All these experiments point to the danger of treating a building material, which shows signs of decay, with any covering which will close the pores. It is sounder to wash the external face of a building thoroughly than to cover it with any preservative which tends to impede free evaporation. When a building shows signs of decay from weathering, it seems, at present, a much more efficacious policy to assist the beneficial action of the rain, and wash down the faces so attacked; this treatment should be carried out in the summer to ensure quick evaporation. Allow them to dry out and wash them again two or three times if possible. This method has proved its efficacy at the Goldsmiths' Hall, in London. It has been washed down two or three times a year for the last thirty years, if not longer, and all signs of incipient decay seem to have been stopped. But similar treatment for interiors is questionable as yet; it would be better to begin by replacing gas by electricity, and suspicious heating installations by up-to-date scientific ones.

One of the dangers which is now being investigated at the Building Research Station, and which has been referred to above, lies in the use of a mortar containing small quantities of free lime, and which is harder and has a smaller porosity than the fabric of the building to which it is applied. The fabric, which then has a greater porosity, will suck the injurious salt out of the mortar, and fall a victim to its own powers of absorption, unless the poison is satisfactorily washed out before the crystals have had time to collect in dangerous quantities.

But if we can bring into play a sort of architectural jujitsu, and make this very power of absorption act as an ally instead of an enemy, we can force it to cast out the poisonous chemical compounds in time to save the structure from unsightly stigma if not from actual decay.

Some day, perhaps, the presence of either will be considered as a similar stigma on the technical reputation of the architect.

D. M. F. HOYSTED.

THE REVIVAL OF A WAR TROPHY TANK.

IN April, 1926, the School of Electric Lighting was requested (through the C.R.E., Wessex Area East), to see if they could move a 30-ton Mark V Daimler-engined Tank, which had been presented to the borough of Portsmouth as a war trophy, and placed in position at a cross-road near the Clarence Pier in August, 1919. The tank had since been found to be a danger to motorists, as it obstructed the view. It was understood that a firm of haulage contractors, which had

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undertaken to move the tank by means of a steam tractor, had been unable to do so.

A preliminary examination showed all unpainted metal parts inside the tank to be very badly rusted, after six-and-a-half years' neglect. An oil-can, which had been left in the tank, crumbled away at a touch; the autovac tank was rusted through; the sparking plugs had been removed, allowing damp, grit, and rust to get into the cylinders; the main and the hand-starting magneto, also the carburettor had been removed; all the water joints were badly perished.

However, as is our usual good fortune in the Corps, a specialist in this particular line was available. Serjeant Rickards, R.E., who had served formerly with the Experimental Bridging Establishment, Christchurch, informed the writer that he could get the necessary hand-starter magneto and the 6-cylinder magneto, carburettor, spare track pins, etc., from Christchurch, for this obsolete make of tank. He obtained the same within 24 hours.

To our surprise, the engine was found to be quite free. It was turned over by hand several times, to ensure that everything was in order, and to start the oil circulation. The ignition was then connected up, and the engine started without much difficulty (with three men on the starting crank, and using a hand-starter magneto).

The 105 H.P. Daimler double-sleeve-valve engine was of the dry-sump type (in order to avoid lubrication trouble when the tank is tilted to steep angles when crossing rough ground). For the first two or three minutes after starting up, the sump oil extraction pump was delivering practically pure water out of the oil sump into the oil reservoir, proving how damp was the atmosphere in which the tank had been left, without being touched, for over six years.

The compression was quite good, and the engine ran quietly, without misfiring, with a clear exhaust.

When the gears were engaged, the tank began to drive on one track only, and it was found that one driving pinion had been removed. Another driving pinion was, however, soon obtained from a similar war trophy tank at Gosport. The tank was then successfully manœuvred into its new position, which was at an angle to the former site and a few yards away.

The two R.E. N.C.O.s employed showed, as usual, great energy and initiative in overcoming various minor difficulties. It was most fortunate that an N.C.O. experienced in the driving of this type of tank was available.

The chief lesson would appear to be the remarkable persistence of the oil film on the working surfaces of a sleeve-valve-engine. It is unlikely that a poppet-valve-engine would have held its compression after such a long period of neglect.

J. H. DYER.

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BOOKS.

A.Q., OR MILITARY ADMINISTRATION IN WAR.

By LIEUT.-COLONEL W. G. LINDSELL, D.S.O., O.B.E., M.C., *p.s.c.*, R.A.

(Gale & Polden, Ltd., Aldershot.) 8s. 6d. net.

It is always interesting to examine the result when a complex is taken out for an airing by its owner. When that owner is an expert, interest is converted to admiration.

Even without the thirteen letters of the alphabet that follow his name, Lieut.-Colonel Lindsell could lay claim to the title of expert on the strength of his *Military Organization and Administration*; this volume substantiates his claims in full.

It is unfortunately true that most officers are only lured into the perusal of a volume on administration for the purpose of satisfying an examiner; those that turn to this volume for that purpose will get full value for their pains. But, luckily, the necessity for passing examinations, *ipso facto*, leads many on to the serious study of their profession. For these, *A. and Q.* will prove a mine in which every page will provide a spadeful of rich treasure. No one could read this volume without appreciating the great truth that sound administration is the basis of all military operations, and he who assimilates the knowledge therein can fairly claim to be competent to tackle the problems he might be called upon to face in war. But Lieut.-Colonel Lindsell does not merely satiate our memories with data, at times he makes advances into the fields of deductions, and in these fields offers a challenge to the powers of the reader. For example, he makes the statement, "The more we consider these big administrative problems, we come nearer to the conclusion that modern wars of the continental type are no longer won by decisive battles, but by sustained and adequate maintenance arrangements."

By "decisive," we understand battles that end a war, such as Waterloo or Jena. It is for consideration whether the true reason for the absence of decisive battles in the Great War did not lie in the lack of appreciation of the enormously enhanced powers conferred upon the defensive by the machine-gun. That balance appears on a fair way to be restored by the development of the armoured fighting vehicle.

The man and the horse can subsist for a definite limited period on inadequate supplies, but the petrol-engine will not give a single revolution without its bituminous rations; so would it not be more accurate to deduce that decisive battles are still possible, but are more and more dependent upon adequate administration?

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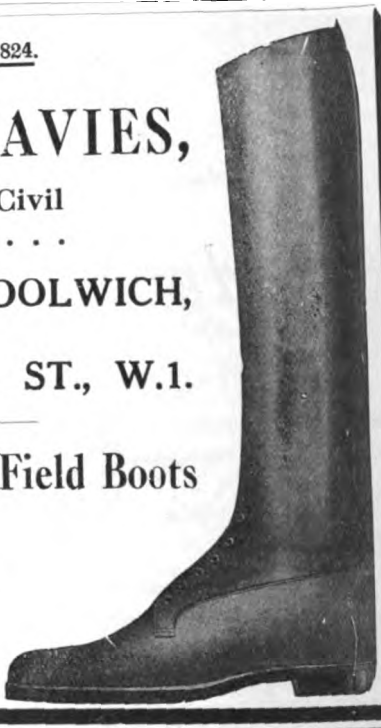

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ARTHUR FFOLLIOTT GARRETT PRIZE ESSAY, 1928.

SUBJECT SELECTED :—WATER SUPPLY ON ACTIVE SERVICE.

AN expedition is to be sent to the Crimea to capture the fortress of Sevastopol. Its strength and equipment are those of the British Expeditionary Force first landed in August, 1914 (4 divisions, 5 cavalry brigades, etc.), but local conditions are as in 1854. The expedition may land where it actually did, or at Balaklava.

You are requested to advise the C.I.G.S. as to the provision of water on and after landing.

An account of the topography and climate of the Crimea, with some notice of the water supply, will be found in *The Medical and Surgical History of the British Army which served in Turkey and the Crimea during the Russian War in* 1854–5–6, Vol. II, p. 15.* In general, in 1854–6, water was obtained from streams, existing wells and springs. This was sufficient in winter, but inadequate for 70,000 men and 10,000 horses in summer.

It may be assumed that, by sinking additional wells to sea-level, sufficient water may be obtained, except in July-August, when the streams nearly dry up and 20 per cent. must be obtained by condensing sea-water. Possibly some of the well-water near the coast will be brackish.

Any assumptions found to be necessary from want of *Engineer Intelligence* must be clearly stated to be such.

Essays must reach the office of the Secretary, Institution of R.E., not later than the **30th November, 1928.** Essays must not be signed, but each essay must bear a pseudonym, and the name of the writer, enclosed in a sealed envelope marked with the same pseudonym, must be attached.

The following are the conditions of the Arthur ffolliott Garrett prize :—

1. The prize, which will take the form of a piece of plate, to be chosen by the recipient, was instituted by Mrs. Garrett in memory of her late husband, Major Arthur ffolliott Garrett, O.B.E., R.E.

2. Qualifications of the recipient : To be an officer on the Active List of the Royal Engineers, not above the substantive rank of Captain on 1st January, 1928.

3. The essay must not exceed **10,000** words.

* By the courtesy of the Librarian, the book can be seen at the War Office Library. *Professional Papers of the R.E.* have been consulted, but do not appear to contain anything on the subject.

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Work of the Royal Engineers in the European War, 1914-1919.

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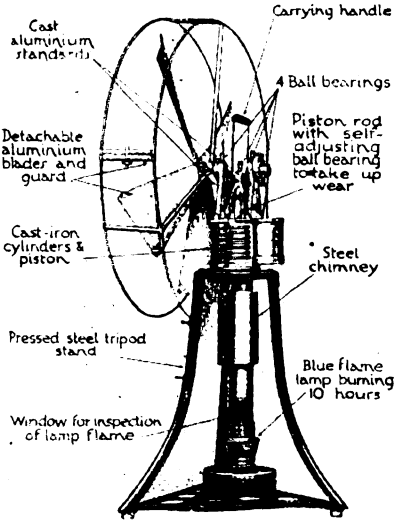
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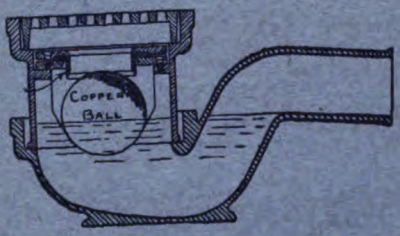

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Lt.-Col. L. Chenevix-Trench, C.M.G., D.S.O..... 1928
Bt. Lt.-Col. G. Le Q. Martel, D.S.O., M.C..... 1928
Major R. S. Rait Kerr, D.S.O., M.C. 1928

Ex-Officio.

Maj.-Gen. G. Walker, C.B., C.B.E., D.S.O. (*Cdt. S.M.E. and Inspr. R.E.*).
Col. G. H. Addison, C.M.G., D.S.O., M.A. (*A.A.G.R.E.*).
Col. G. R. Pridham, D.S.O., O.B.E. (*Pres. R.E. Board*).
Col. R. F. A. Butterworth, C.M.G., D.S.O. (*A.D.W.*).
Col. R. Oakes, C.B.E. (*A.D. of T.*).
Col. H. St. J. L. Winterbotham, C.M.G., D.S.O. (*G.S.*)
Bt. Lt.-Col. G. B. O. Taylor, C.B.E. (*C.I.C.*).
Bt. Lt.-Col. C. A. Bird, D.S.O., *p.s.c.* (*C.I.F.W.*).

Corresponding Members.

Lieut.-Col. J. E. Duigan, D.S.O., *p.s.c.*, N.Z.S.C. (late R.N. Zealand Engrs.)..... 28 10 24
Lieut.-Col. A. M. Martyn, C.M.G., D.S.O., Australian Staff Corps (late R. Aust. Engrs.) 20 4 26
Lieut.-Col. Sir Tannatt W. Edgeworth David, K.B.E., C.M.G., D.S.O., F.R.S. 12 1 29

Secretary: Lieut.-Col. P. H. Kealy, 1st October, 1927.

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NON-POLITICAL TRADE UNIONISM.

A Lecture delivered at the S.M.E., Chatham, on October 4th, 1928, by W. A. APPLETON, ESQ., C.B.E., *Secretary of the General Federation of Trade Unions.*

NOTHING is so conducive to accurate thinking and satisfactory understanding as careful definition. To express clearly, even to oneself, terms or propositions to be advanced, is to anticipate and prepare for criticism, and perhaps to avoid unpleasant reverses. If this ideal were realizable, if it were always possible for truly scientific minds, after carefully defining, to analyse, and pursue to logical conclusions, every catch phrase which disturbs the public peace, and then to broadcast the results, three-fourths of this country's industrial, social and political turmoil would be avoided. Indeed, it may with truth be said that our commonest troubles are those arising from proposals, attractive enough in appearance, but impossible of realization ; which are put forward by suffering people who cannot think, by careless talkers who will not think, or by persons who only think of political advancements and emoluments. The first class deserve to be pitied, the second satirized and the third court-martialled.

A very large number in this first class belong to trade unions, or to those who are associated with trade unions, and when studying them, their organizations and their association with political parties, it is desirable to differentiate between trade unionism and trade unions, and to say what we mean by politics. Of trade unionism and trade unions—one represents the spirit of the movement, the other the structure. The former is older and wider ; it goes back to the brickmakers employed by Pharaoh, or even beyond, and is practised by the professions as well as the trades.

Forms of trade unionism appear to have existed in Rome, under the Cæsars, and also slightly later, in France and Asia Minor.

Examinations of the foundations of Notre Dame, in Paris, afforded evidence of the use of materials from the Temple of Jupiter which, it is stated, stood upon the same site. Amongst the discoveries made by the excavators was an altar, whose inscriptions indicate that it was placed there by the Boatmen's Union of the Seine ; which is asserted to be an off-shoot of the original Boatmen's Union of the Tiber.

In Sardis, Asia Minor, Mr. W. H. Butler, an American Economist and Archæologist, is said to have discovered a tablet which records

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a building trades' agreement bearing date of April 27th, 459 A.D. This agreement follows upon what appears to have been a lightning strike, for work was left uncompleted. The settlement ultimately effected was a collective one, and covered conditions of employment, wages to be paid and penalties for default.

If antiquity confers respectability, trade unionism is amongst the most respectable of movements. If opposition strengthens, then trade unionism should be one of the strongest of movements; for when Cæsar became Emperor, he issued edicts against it, and Cicero carried a measure through the Roman Senate, which made a number of workers' craft organizations illegal. Our own thirteenth to nineteenth century prohibitive, or restraining legislation, seems, therefore, to have been imitative rather than original.

Trade unionism is not a constant proposition, or an exact science like mathematics. Rather may it be described as a movement actuated by human desires and bounded by economic possibilities. This being the case, its inconsistencies and its selfishnesses, as expressed in the professions and amongst the manual workers, may cause annoyance, but ought not to occasion surprise. It would be wiser if these expressions were regarded as inevitabilities, and either encouraged or repressed, as they made for, or against, the common good.

To attempt even this method of apprehending and directing, and if needs be controlling, craft and professional unionism, it will be necessary to study the philosophy—that is the causes, the circumstances, and the aims of the movement—and also its history. Especially is it necessary to study that portion of trade union history which deals with the structural and operative sides —that is, how constituted, how directed, and what means are used to enforce policies.

The genetic causes of trade unionism are to be found:—

(1) In the eternally operating desire of men to secure the fullest material reward for personal effort, and in the early realization of the increased effectiveness of combined activities.

(2) In the equally powerful desire of other men to advantage themselves by exploiting the efforts of the less fortunate or less capable members of the human family. The clashing of these factors produced the movement.

In the professions there is the added incentive of ambition, or pride in the standing of the particular profession. Amongst the workers, additional incentive results from the desire to provide against unpleasant contingencies, such as victimization, starvation, or ill-honoured old age.

Trade unions, as we know them, and as apart from employers'

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associations and organizations, are, at least in theory, voluntarily constituted for the betterment of wages, hours and working conditions; of people engaged on similar materials, using similar tools, and producing similar results. This description, by slightly varying the terms, will apply to the professions as well as to the trades.

In England, trade unions have had legal existence since 1824. In the form of Friendly Societies, they existed surreptitiously from much earlier times. Indeed, the Silk Hatters' Trade Union claims to have received Royal approval in 1576, and it is still in existence. The Cotton Spinners of Oldham have rules bearing date of 1797, and the records of the Friendly Society of Ironfounders go back to 1809. These, and contemporaneous unions, owe their origin to changing, and mostly oppressive, circumstances.

Methods of production are always changing; sometimes rapidly, sometimes slowly, but always changing. These changes bring fortune to some, misfortune to others; and, at least in their earlier stages, they appear to prejudice most those who are weakest and poorest. The industrial changes taking place in the eighteenth century were far-reaching and poignant, for they involved, amongst other disagreeable things, the substitution of the machine for the man. The free craftsman buying his own raw materials, making commodities of his own design, and acting as his own salesman, was at this time giving place to the employee, who, having neither tools nor capital, sold himself to the employer who had both.

The employer, with few exceptions, was disregarding most of his human obligations; his only thought being personal, immediate, and financial success; and the only chance the workman had of securing anything in the shape of equality of bargaining power was by combining with his fellows.

Sporadic combinations proved of little value; control was limited, communication difficult, resources easily exhausted; and so the continuously existing organization, the trade union as it is understood to-day, making careful provision for disputes, and some provisions for social disabilities, grew in favour and in strength.

The need for such unions was demonstrated by the conditions obtaining; long hours, low wages, unhealthy and soul-destroying surroundings, all clamoured for consideration and redress.

The seriousness of the industrial situation in the early part of the eighteenth century is demonstrated by the House of Commons Reports.

In 1832, Abraham Whitehead, giving evidence before a Special Committee of the House, gave poignant and substantiated evidence of the brutal practices which accompanied the employment of little children; a brutality which employers practised and parents acquiesced in. Commencing work between the ages of five and six years, they would be called out of bed, winter and summer, in time

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to reach the mills before 6 a.m. No time was allowed for breakfast, food, such as it was, being snatched while at work. In summer, the time allowance for dinner varied, some mills allowing as much as from forty to sixty minutes. In winter, no time was allowed, even for the mid-day meal, but, in some cases, ten or fifteen minutes was taken. These little children, when at work, were always on their feet; they could not sit and piece, and Whitehead declared that: "It is a very difficult thing to go into a mill, in the later part of the day, and not hear some of the children crying for being beaten; some have been beaten so violently that they lost their lives in consequence."

In Kirkheaton Churchyard there is a monument, erected to the memory of seventeen children who, in 1818, lost their lives at the burning of Atkinson's Cotton Mill, Colne Bridge. The fire broke out during the night shift, and while the children were locked in. The foreman who had the keys in his possession failed to open the doors, and seventeen lives were lost. The eldest victim was eighteen and the youngest, nine! This occurred, not in darkest Africa, but in benighted England; not in mediæval ages, but in 1818, and at a time when little children were being taught to sing:—

> "I thank the goodness and the grace
> Which on my birth has smiled,
> And made me, in these Christian days,
> A happy English child."

Low wages, high prices, and soulless cynicism, were aggravated by the practice of "truck"; a system so nefarious that Parliament made it illegal in 1831. This system enabled the employer to make profits both ways—out of his employee as producer, and also out of him as consumer; for in addition to compelling him to work long hours for low wages, it also compelled him to purchase some at least of his meagre domestic necessities from his employer's store, and at the latter's prices. Sometimes the workman was compelled to pay for lighting and for shop room; and, though the restraining Act was passed in 1831, Parliament, in 1842, was constrained to take further proceedings; while in fact the practice persisted to 1870 or even later.

In the tragic days preceding the passage of the 1871 Trade Union Act, even though the Combination Laws had been repealed, and Trade Unions made legally possible, persecution and mal-interpretation of the law still made organization difficult, and intensified the struggle between those who employed and those who were employed. The recorded cases of the Printers, the Weavers, the Coopers, the labourers of Tolpuddle, and other Unions, show how great is the historical justification for the antagonism which exists towards the employing class.

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In 1810, the Journeyman Printers in London suffered sentence under the 1800 Statute, while in 1824, the great year of repeal of these Combination Laws, the Scottish Weavers were prosecuted for calling a strike to enforce a wage rate actually fixed by the Justices. They were convicted and sentenced to terms of imprisonment extending from four to eighteen months. There were occasions when the Courts declined to convict, but these occasions formed the exception rather than the rule. In 1821, members of the Coopers' Society were arraigned at the Old Bailey before Newman Knowles, Esq., Common Serjeant of the City of London, on a charge of conspiracy. The indictment contained sixteen counts; it declared that the workmen, who were named, together with diverse other evil-disposed persons, to the number of one hundred and more, being workmen and journeymen in the art, trade and manual occupation of a cooper, wrongfully, unlawfully and unjustly did contrive and intend wrongfully and unjustly to increase and augment the wages of themselves and other workmen and journeymen in the said art, trade and occupation, and unlawfully and unjustly to exact and extort, great sums of money for their labour and hire in the said trade and occupation, from the masters who employed them therein.

The other counts vary little in substance, but the third count states that the object of the conspiracy was to demand and exact and obtain, for themselves and *other* workmen, one shilling a day more than they had before that time been accustomed to receive.

Seven counsels were employed, three by the Crown and four by the men. The verbatim report of the trial fills two hundred and fifty pages of fairly close print. Short extracts from the Common Serjeant's summing up, and an incident after the verdict was given, indicates his bias. He said to the jury: "You have heard of men having a right to demand what they please, and that these men were to be crushed to the earth and to be ground to powder; such topics might suit meetings which were held for these *illegal* purposes; no persons have a right to insist on what they, as a body, shall receive from their employers, and, if that principle was to be adopted, there would be an end of all commerce. . . . These men have received, all of them, without exception, very good characters, but character weighs less in this case than in any other. . . . It has been said that this is not a conspiracy by the defendants to raise their *own* wages, but I think, so far as that observation is entitled to any weight, that it operates as an exaggeration, and not an extenuation of the offence, because the men who are to derive their support from their wages are more excusable certainly, in attempting to raise their wages, than those who are not to receive any part of it, but who join in an illegal conspiracy to enable other persons to get greater wages." Evidently the Common Serjeant was not himself an altruist, nor did his philosophy visualize the idea of doing unto others as one would be done by.

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In spite of the Common Serjeant's summing up—perhaps because, and in reprobation of it—the jury brought in a verdict of "Not Guilty" on all the counts and in respect of all the defendants. The announcement of their verdict brought expressions of approbation from the people in the Court, and of temper in the Judge, who ordered: "Officers, mark those persons who disturb the Court and take them into custody!"

The case of the labourers of Tolpuddle, in Dorsetshire, affords what is regarded as a classical example of prejudiced application of perverted law. In 1833, these labourers, who were receiving 7s. per week, heard that others in different parts of the country were receiving 10s. They approached the farmers who were their employers, met them in the presence of the parson, and were conceded an agreement for 10s. per week. A little later the men were ordered to go to the County Hall, and there were magisterially told they must work for what their employers thought fit to give them. This intimidatory advice was followed by an immediate reduction to 7s. per week, and the threat that they would shortly have to be content with 6s. Having in this way effectively learned that it would be vain to seek redress from employers, magistrates or parsons, these men decided to form a trade union.

That they had no intention of acting against the King's person, or his realm, is proved by their rules which declared: "That the objects of the Society can never be promoted by any act of violence, but on the contrary all such proceedings must tend to injure and destroy the society itself."

Only a little time elapsed between the formation of the Union, on the 21st October, 1833, and the outward and visible expression of opposition by the employers; for on the 21st February, 1834, just four months after the Union's formation, placards were posted in the district, warning the labourers that membership of the Union was a crime, punishable by seven years' transportation.

No demands had been preferred by the men, no employers threatened in person or goods, but, within three days of the placards being posted, six labourers were arrested and thrown into jail. Though the Combination Laws had been repealed in 1824, and this was 1834, these labourers were sentenced to seven years' penal servitude, just the period threatened by their enemies prior to their arrest. An old and forgotten Statute was invoked against them; a Statute devised for entirely different purposes, but which dealt with the taking of oaths and the adoption of passwords. These labourers had, unknowingly, transgressed some of the regulations of this forgotten Statute, and seven years' penal servitude was their sentence.

The Times, on the 1st April, 1834, declared: "That all Freemasons and Orangemen . . . might, with equal justice, be sentenced to

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transportation by reason of them having taken secret and unlawful oaths, such as taken by these poor fellows." In studying this trial, it is difficult to escape the conclusion that, if this Statute against the taking of oaths should happen to be resuscitated, some of the good soldiers I have known would spend most of their lives in jail!

That the spirit which dictated the Statute and the sentence continued to exist, was confirmed by personal experiences in the later years of the nineteenth century; these experiences vitiated the surprise, though not the disquiet felt, when the trade unions turned their attention from economic to political action; from securing equitable shares in the profits of production, to controlling shares in the affairs of the State.

The earlier conceptions of trade unionism in Parliament presupposed representation rather than domination. The movement had accomplished wonderful things in respect of industrial and social ameliorations, but they constantly found themselves checked, or even check-mated, by oppressive legal interpretation, or by resus citation of laws passed in other times and to meet different situations. They had spent many millions in relieving unemployment, sickness, old age, and in the interment of deceased members; but industrial conditions, as governed by legal enactment and interpretation, eluded them, and were far from being satisfactory. Parliament was in the hands of those who were their industrial opponents; to associate with these was to acquiesce in tortuous and tortoise-like progress. Some members of Parliament, out of sagacious goodness, had assisted the trade unionists, but the majority were against them; why not, therefore, replace these members by men of their own class and habits of thought?

The reverberations of the French Revolution and the fulminations of Karl Marx, were appealing to people who suffered under stupidly harsh applications of obsolete laws, and who remembered the unscrupulous brutality which had characterized industrial expansion. To many, incitement to political control seemed like the call of God. Incapable of chicanery themselves, they rarely suspected it in others, and believed, in all honesty, that political power, of necessity and as a matter of course, involved economic efficacy, industrial progress and social regeneration. Dissatisfied with that limited Parliamentary representation, which had been permitted through association with Liberals and Conservatives, they hailed the idea of a Labour Party, consecrated to the achievement of their ideals, with rather modified but fairly general enthusiasm.

The Trade Union Acts of 1906 and 1913, gave both trade unionists and adventurous politicians opportunities which other times and enactments had denied them. In effect, the Act of 1906 abrogated the Law of Conspiracy as this affected Trade Unions, because, so far as they were concerned, it abolished torts, tort being a term

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including all those wrongs, not arising out of contract, for which remedy by compensation or damage is given by law.

The addition of a few words to the first paragraph of Section 3, of the Conspiracy and Property Act of 1875, materially altered its original intention by declaring that: "An act done in pursuance of an agreement or combination by two or more persons, shall, if done in contemplation or furtherance of a trade dispute, *not* be actionable unless the act, if done without such agreement or combination, would be actionable (Section 1)."

To add definiteness to the alteration, Section 3 (of the 1906 Act), declared that: "An act done by a person in contemplation or in furtherance of a trade dispute, shall not be actionable on the ground only that it induces some other person to break a contract of employment, or that it is an interference with the trade, business, or employment of some other person, or with the right of some other person to dispose of his capital or his labour as he wills."

Whatever the legal interpretation of these clauses may be, the interpretation deduced and acted upon by the trade unionist, and those advising or profiting through him, was that no action would lie against him if it could be pleaded that interference with the individual, or conspiracy to secure breaches of contract, arose in contemplation or in furtherance of a trade dispute. The fact that legal action has seldom or never been taken confirmed their opinion.

This opinion was further encouraged by the Trade Union Act of 1913, which amongst other things, empowered Trade Unions, by a majority vote of the total membership voting, compulsorily to extract a general and continuous contribution to the funds of a particular party; this, of course, being the Labour Party. This Act of 1913 reversed ordinary practice in the matter of contracts by compelling contracting out of a not previously existing liability, instead of contracting in. As a specified form had to be applied for, and filled up, and signed and returned to the secretary, and some obloquy incurred, the non-contents—the Liberals and Conservatives—went on paying rather than run the risk of ragging.

Political trade unionism became an organized force when, in 1890, the Labour Party was brought into existence. The 1913 Act was to this Party what an addition to a deficient commissariat is to an army.

Considerable difference of opinion exists as to what constitutes a political trade union. It is quite fair, I think, to say that a trade union becomes political when it identifies itself with or undertakes continuously to subscribe to the funds of any particular political party, or when, as a matter of considered policy, it uses industrial power to assist a political party to secure political objects; irrespective of the effect of such action upon the union's industrial prospects.

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Politics has been defined as the art of government. At best, the term should imply much more, for it should be expressive of science as well as art; of knowledge acquired, methodized, and made applicable to thought and movement; as well as to skill and manipulative dexterity when dealing with human and economic factors. The term should presuppose, not merely the idea of controlling men and affairs, but also the intention of directing both these along constantly ameliorating planes of ethics and activities. Politics, therefore, may be described as a term postulating apprehension and direction of the desires and affairs of men and nations; and a politician as one who, amongst other things, should be well skilled in the art of applying deductions drawn from psychological and historical knowledge.

There are, admittedly, other definitions and conceptions of politics and politicians, and these not so flattering as the idealistic ones now submitted. In all countries there are politicians who pay little regard to the ideal, but who regiment themselves for the purpose of securing control, direction and emoluments. In Great Britain there are three generally recognized groups, each having its share of idealists and adventurers—Labour, Liberal and Conservative; or, if you like, positive, comparative and superlative. No one, in view of its utterances and activities, will deny Labour's claim to be positive, though there may be some differences of opinion over the allocation of the terms " comparative " and " superlative."

To each of these parties, their members and their executives, are ascribed intentions, qualities and capacities entirely outside my own idealistic description. Artful, cunning, crafty, foxy, untruthful, mercenary, unscrupulous, machiavellian, are amongst the milder epithets applied by opposing factions.

At the moment, and for the present purpose, I am willing to postpone consideration of the baser kind of politician, and temporarily at least, assume that my description of politics and politicians holds the field. If that is agreed, one sees at once how great are the issues involved, how wide are the psychological and physical areas to be covered, and how futile must be all attempts to subordinate real politics, which would take cognizance of international, as well as national and local desires and potentialities, to the exigencies of the trade union or any other particular movement. Yet this is exactly what has been attempted, particularly during the present century.

The hopeless impracticability of this policy is obvious to the thinker who is intelligent and honest. Unfortunately, men desire first, and think afterwards, and to only a minority of those who find themselves compelled to think can we unreservedly attribute the qualities of intelligence and honesty.

In this problem, as in many others, elements of truth which it contains increase the difficulty of exposing fallacy. It cannot be

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denied that some trade or occupational unions benefit by political action. Obvious instances are the National Union of Railwaymen, the National Union of Teachers, the Post Office Workers, and various unions enrolling civil service workers. Even here, however, purely partisan politics may, if long views are taken, become a serious disadvantage (*e.g.*, N.U.R.). For the unions enrolling workers engaged in competitive industries, especially where competition is from overseas, and where economic pressures render sentiment ineffective, the independent policy is the better one. This permits negotiation between trade union officials and employers' representatives not being prejudiced by political predilection, and ensures a better chance for purely industrial and economic subjects.

It is frequently said that trade unions sometimes act against the common interests of society; so do the professions and so do employers and employers' associations. No one suggests that meat and milk distributors are unadulterated philanthropists.

The way to prevent or mitigate the evils which exist in this connection, is not easily ascertainable. It is not by ill-considered applications of force. You cannot compel employers to pay uneconomic wages; neither can you compel—or at least, you ought not to compel—workpeople to accept wages which do not provide subsistence. As Cæsar and Cicero failed to suppress, so shall we. Unions, trade and professional, will openly or clandestinely continue to exist, and this so long as industrial or occupational grievances run across human desire or need, or until all their functions are absorbed by the State, or until the removal of injustice and unfairness is scientifically and religiously undertaken by the whole community.

In conclusion and in extenuation of many things, let me say that in the sense that trade unionism involves combinations against industrial aggression, it has been in existence thousands of years and will probably continue until the millennium. In its modern form it has ebbed and flowed; made mistakes and recoveries; attempted too much and done too little, particularly since it went into politics; but, industrially speaking, it has been the one force making for equality of bargaining power and just dealing between those who buy labour and those who sell.

Critics, many of them honest and capable workers at their trade, complain that in entering into party politics it has wandered, or been led, outside its proper and practical functions. Perfectly true, and its errors should be explained and condemned; but it ought not, any more than Christianity, to be judged by all the silly things done in its name.

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THE 23rd (FIELD) COMPANY, R.E., IN THE GREAT WAR, 1914–18.

(Continued.)

By MAJOR R. L. BOND, D.S.O., M.C., R.E.

PART III.—NOVEMBER, 1914—SEPTEMBER 30TH, 1915.

Battle Honours during the period—" Aubers," " Loos."

THE period, November 17th to December 20th, was spent in rest at Borre.

Capt. H. W. Herring, R.E., joined the unit on November 18th, *vice* Capt. Addison.

The first few days were spent in cleaning up, overhauling tool carts and general stock-taking. The latter process disclosed an unexpended surplus of about 100 lbs. of " plum and apple," more tobacco than could be smoked in a year, and vast quantities of shirts, the gifts of generous friends in England. Stafford, revisiting the farm in 1918, found a bale of these shirts still unopened and jealously guarded by our good friends the Oudinots, who always retained a great affection for the Company.

The time was spent in work on roads suffering from heavy traffic and severe weather, repairs to infantry billets and improvements to horse lines, and very largely in design and construction of various types of trenches, embodying the lessons learnt during the previous two months. These lessons were :—

(*a*) that overhead cover to a fire trench was undesirable, being no protection against H.E. shell ;
(*b*) fire bays not to be more than 15 feet in length ;
(*c*) ample traverses ;
(*d*) plenty of room in the fire trench for traffic without interference with firers.
(*e*) the practice of undercutting the firing parapet for protection from weather and shrapnel fire was most undesirable and dangerous.

The method of provision of shelter still remained to be solved.

Much time and thought was expended on the design and construction of some form of bomb-gun. The jam-tin bomb was now almost a standard article, and the problem was to throw it as far,

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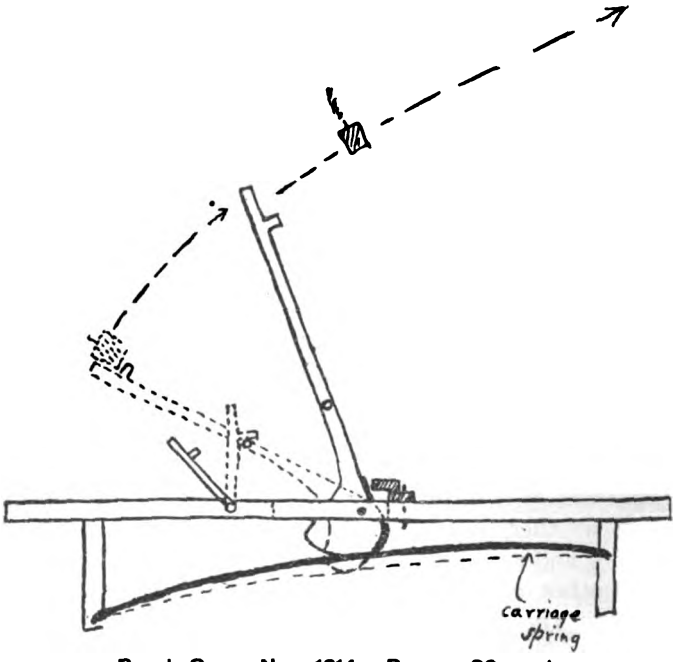
as accurately, and as silently as possible. Each Section in the Company had its pet design. Some people found it necessary to go to Paris to obtain powerful helical springs to make a gun working on the pop-gun principle. This was not a great success, throwing the bomb some 50 to 60 yards. The cross-bow principle was tried, but there were difficulties in obtaining sufficient powerful elastic. One gun (Sketch No. 9) of simple design, weighing about 30 lbs., was more successful, based on the principle of many a toy cannon of childhood days. This gun threw a bomb 80 yards with accuracy.

SKETCH No. 9.



Bomb Gun. Nov. 1914. Range: 80 yards.

The experimental model was taken into the trenches on Christmas day, but in the excitement of coaxing an unwilling fuze to light, the inventor unwarily placed his face in the arc of movement of the arm, the fuze spluttered, the trigger was pulled and the gunner received a powerful buffet which stretched him alongside the weapon. However, the bomb was duly thrown to the right place, but the gunner had cut his face open, and on returning early next morning found the beloved weapon had been used for cooking a guardsman's bacon. The design was handed over to the new bomb factory in Bethune, where it was improved (!) by the expert mechanics into a gun weighing about 90 lbs. and throwing a bomb not more than 50 yards. The child was still-born.

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Brainwaves from the War Office were sent out for trial, mostly suggestions for putting up wire without getting out of the trenches. Much joy was caused by some of these, particularly one bright patent. This consisted in coiling a rope several times round an expandable drum of wire. The end of the rope was fastened to a pole so that when the wire coil was lifted on the parapet and the fisherman made his cast the coil rolled forward some ten yards. Two gillies assisted by pulling ropes attached to the ends of the coil, which was thus expanded. It not only expanded but, of course, rolled back into the trench.

On December 3rd, His Majesty the King paid a very welcome visit to the Division, the units being lined up on the main road for inspection.

During this time, visits were paid to the Sappers and Miners at Le Touret, a billet we were to know well later on, and to the French Cie du Génie of the 32nd Division, who had taken over our old bridge near Boesinghe.

At last, in the middle of this peace, an order was received at 3.30 p.m., on December 20th, to move immediately. This was cancelled at 4 p.m., but at midnight an order arrived to march at 7 a.m. on the 21st, to the neighbourhood of Bethune. The horses had for some time been out at grass in a paddock surrounded by high hedges, but on this particular morning, of course, it was discovered that about 30 horses were missing. Nearly all were recovered, grazing quietly in the neighbourhood, in time to move off at 7.0, but six draft horses, Alexander the Great (Bond's horse, a fine, well-mannered, dark chestnut, with an Olympia record), who had jumped out of the field, leading the rest and R.B.'s two cobs, were nowhere to be seen. No. 2 Section, therefore, was left for the time. A search eventually discovered the six hairies wallowing in turnips about a mile away, but the riders had disappeared.

Some two miles from Locon, Capt. Herring and No. 2 Section, after a long march in a wet and depressing day, were endeavouring to trace the Company, and were much assisted by a young subaltern in the Grenadier Guards, standing outside his billet, who helped to interrogate the inhabitants. It was not till later that it was realized that our friendly interpreter was H.R.H. The Prince of Wales. Eventually the whole Company, after first making for Vieille Chapelle, was ordered to Locon.

The following morning, standing outside the billet, watching the passage of a gunner brigade of the 2nd Division, the writer noticed a B.S.M. riding Alexander the Great, followed by R.B.'s two cobs hauling a gun! The runaways were very soon retrieved to the chagrin of their temporary owners.

It will be remembered that, on December 20th, a powerful German attack had been opened against the Indian Corps at Givenchy and

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Festubert and that the 1st Division had been hurried to the scene on the night of December 20th/21st to assist in restoring the situation* ; by the evening of December 22nd, the 1st Division had taken over a considerable portion of the line, Givenchy and northwards, from the Meerut Division. On the night, therefore, of the 22nd December, the 23rd (Field) Company Sections found themselves assisting the 2nd K.R.R. (2nd Infantry Brigade) near Quinque Rue in the construction of a new line, in close co-operation with the Bengal Sappers and Miners on the left. The night was wet, enemy searchlights were ubiquitous and conditions very unpleasant, though the ground had not yet reached its later water-logged conditions. The flatness of the country and the winding nature of the line produced a phenomenon with which we were to become better acquainted in the spring. Shots fired near the front travelled a long way, and moving up over the flat roads to work, tired bullets would constantly strike the roads from all sorts of queer directions, whilst the area within a mile of the front was consistently unpleasant, and, except for scattered buildings, devoid of the defilading cover of the Aisne slopes. Curiously enough, however, in several months of work, the Company had practically no casualties from this source, though other units were less fortunate.

On the 23rd, the Company, having taken over the Le Touret billets from the 21st Company Sappers and Miners, spent the day in making bombs, preparing fascines and one section went forward to assist the 2nd R. Sussex.

On the night of the 23rd/24th, the unit moved to Essars and on the 24th for Cambrin, arriving late that night at Beuvray, where the generous owners of the billets provided a splendid Christmas dinner. The move to Cambrin followed the next day, Christmas Day, the sections going out almost at once to work, two sections on the pontoon bridge, 600 yards west of Pont Fixe, and two sections in the trenches.

In this sector (Sketch No. 10) the Company remained for more than six weeks. The sector consisted of the brickfields north of the Bethune–La Bassée Road, a low-lying clay area dotted with stacks of bricks, each stack some 40 to 50 feet square and 15 feet high. The dominating feature was the railway embankment on the north, and the railway triangle surrounding a canal basin on which the enemy had strongly established themselves. Photographs giving a good idea of these main features are appended.

The French had been established in the brickfield for some time, and had constructed a strong fire trench with deep dug-outs (our first experience of this form of shelter), and long communication trenches running back nearly a mile to Cuinchy. In dry weather, these communication trenches, 5 to 6 feet or more deep, had stood well in the firm clay without revetment ; whilst the trench bottoms

* *Military Operations in France and Flanders*, 1915. Page 21.

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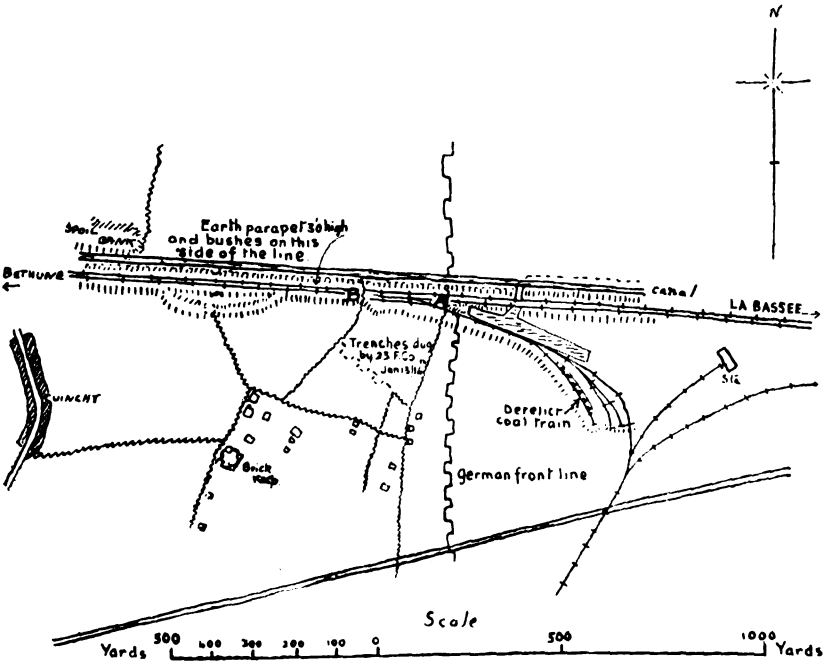
had been carefully laid with brick, forming a hard paving. The rain, frost and snow of December, however, very soon commenced the disintegration of the clay walls, no drainage had been provided, and the communication trenches rapidly filled almost waist-deep with a glutinous mass which made the task of carrying parties, ration parties and individuals one of superhuman effort. On many occasions, men had to be dug out and the moral and physical effect of these conditions was serious. At the same time, although the front line, and a support line some 200 yards in rear, were in fair

SKETCH No. 10.



Cuinchy Brickfields, January, 1915.

condition, there was no system of supporting points in rear of these lines, and barbed wire defences were conspicuous by their absence.

The two main works on which the Company was employed in this area, then, were the drainage and maintenance of the communication trenches and the construction of rear defences. So far as the first work was concerned it was a constant labour against odds. Large sump pits were dug, experimental pumps of various patterns installed and every effort made to drain the trenches, but the intermittent battle described below constantly interfered with this work. The main work in defence was the construction, amongst

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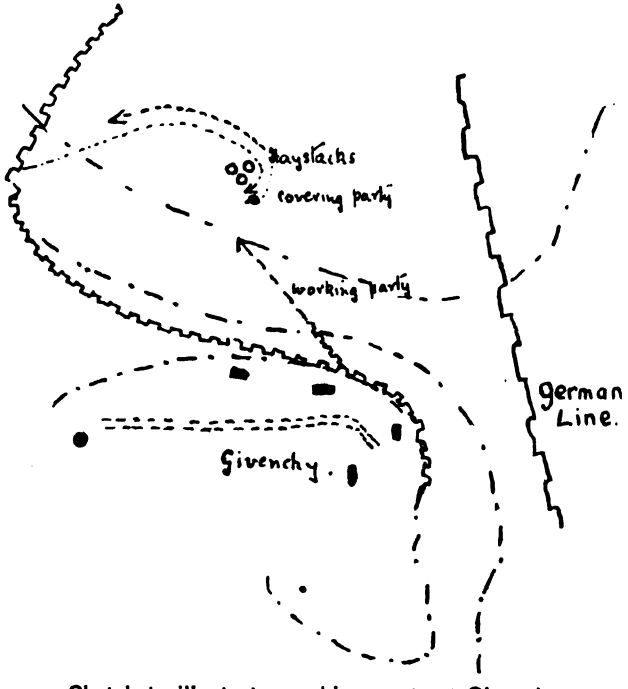
some brick stacks standing fairly close together, of a "keep," as strong points were called at this period, made of brick. Strong brick walls, properly made with cement mortar were built, 6ft. 6ins. high, loopholes constructed, and arrangements made for all-round defence. Built amongst the brick stacks, the work was never noticed by the enemy, and was as great a success in stopping the attack of January 25th, as the Black Watch strong point had been on November 11th.

North of the canal, the ground rose gently to the village of Givenchy, and here again trench drainage and the construction of

SKETCH No. 11.



Sketch to illustrate working party at Givenchy.

"keeps" were the main work. North of Givenchy, the position was somewhat unsatisfactory after the December fighting, the line curving back before joining up with the Festubert trenches. The German line, however, had not bulged into this arc and it was decided to construct a new line from Givenchy across the chord. The operation provided a nice illustration of the difficulty of maintaining direction at night (See Sketch No. 11).

Preceded by a covering party of one platoon, Herring led the sappers out from the flank, followed by a working party of 150 men of the battalion holding the line. The party had just commenced to extend when there was a tremendous outburst of rifle fire from

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our trenches, duly responded to by the enemy in front. The working party lay very tight until Herring, having wriggled out of the zone of fire, ran into the line and got the firing stopped. It then appeared that the covering party, having made a circle of some haystacks, had lain down facing the wrong way, had mistaken the working party for approaching enemy and run back the way they had come to give the alarm. However, luckily, an estimated expenditure of some 10,000 rounds by both sides only produced one slight casualty. The work was then carried out successfully.

"Keeps" were constructed in Givenchy, and mines laid for electrical firing from the keeps. On one occasion, Mallins went out with some London Scottish Scouts and blew up an inconvenient house in front of the line.

Amongst other works carried out during the period were the construction of a heavy timber dam at the lock gates, which the Germans constantly endeavoured to damage by gun fire; the commencement of offensive mining, unfortunately stopped by the German attack of January 25th, which captured our mining party including Corpl. A. B. Smith and two men; bomb-making and the construction of an O.P. in the factory at Cuinchy.

There were two battle periods. Early in January, the Germans, by heavy trench mortar fire, wiped out the front line defences on and near the railway embankment at which point our line was inconveniently close to the railway triangle. The enemy then installed himself on the embankment and on a somewhat defiladed hummock, 200 yards nearer our lines. From this vantage point, and assisted by bushes growing alongside the line, snipers made things most uncomfortable over the whole brickfield area. An early counter-attack by the Scots Guards was unable to hold its ground, the exposed embankment being an absolute death-trap. On January 10th, a more deliberate attack was carried out after a preliminary bombardment, by five parties of the K.R.R., each of an officer and ten men, and one officer and ten men of No. 2 Section, 23rd (Field) Co. At 2 p.m., the attack commenced. The two parties of K.R.R., who made for the forward post (point A in Sketch No. 10), were wiped out almost immediately, one wounded officer making his way back along the line. The third party and the R.E. making for the hummock (point B), were more successful, captured several prisoners, and although attempts to cross the line drew heavy machine-gun fire, the infantry, whose officer had become a casualty, lay in the shelter of the hummock in a position whence they could fire up the line. Two sappers were seriously wounded trying to get across the line, one dying of wounds that night. Lce.-Cpl. Lee, R.E., and one or two more sappers, very gallantly got these men back into shelter, and the work of consolidation commenced. For his gallantry and splendid example on this occasion, Lce.-Cpl. Lee received the

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D.C.M. Stafford's section had, meantime, pushed its way along a water-logged old trench leading to the embankment and commenced to pass sandbags full of brick to No. 2 Section, some of whom had also started to dig in from the shelter of the hummock. A half-hearted counter-attack along the embankment was driven off by rifle fire. In the meantime, the two remaining parties of K.R.R. had started forward along the foot of the embankment towards the captured post, but were caught by a machine-gun and practically wiped out.

However, the brick wall was rapidly pushed out, one or two sappers wriggled across the line and established themselves in a post amongst the bushes on the far side, commencing to dig from that side. By dark a good trench had been dug right across, some wire had been put up and the post was fairly well established.

Mallins (No. 4 Section) and two Sections, 1/1 Lowland Field Company, R.E., relieved Nos. 2 and 3 Sections in the work of consolidation about 6 p.m. The Lowland Field Company had just arrived and this was their first introduction to front-line work. The occasion was marked by an excellent bit of work by Lieut. Clarke and his Territorial Sappers.

As they were arriving at the head of the Sapper party, and were still some 200 yards from the embankment, the outline of which could just be seen against the star-lit sky, one or two well-directed trench mortar bombs dispersed the small infantry garrison with several casualties, and it appeared that a counter-attack was in progress. Lieut. Clarke at once fixed bayonets and led his men forward at the double, establishing themselves on the post, and dealing effectively with the small German party that was endeavouring to push along the line. For a first appearance in the battle area, this was a fine effort, and was a measure of the high standard from which our Lowland friends never afterwards fell away.

It but remains to add that a few nights later this post was once again heavily trench-mortared, and this time the enemy regained possession. It was then decided to leave ill alone and to construct a switch trench facing the embankment. As this was a somewhat ticklish job, it was decided to carry it out with R.E. labour only, and, on a dark night, Nos. 1 and 2 Sections moved out in file on a compass-bearing from the existing front line, both Sections on a long tape knotted at 15 and 6 feet intervals, one man per knot. The distance had been correctly estimated and the trench was dug with success, to a depth of 3 feet, giving thus the normal 4 ft. 6 ins. cover, with 6 ft. traverses. It will be seen that each pair of men had one fire bay and one traverse to construct, about 240 cubic feet for each pair. This task was carried out in five hours, a good bit of work.

On January 25th, the great Kaiser's birthday attack took place.

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After overrunning the front line the enemy bumped into the brick keep, which was a complete surprise, and, garrisoned by a company of the Loyal North Lancs, completely held up the enemy's advance. Later on, a determined attack was made on the keep which entirely failed, an attack described to the writer by an infantry serjeant who was in the keep, with tears of laughter running down his cheeks. The enemy apparently brought mattresses and pillows, chairs and step-ladders into the fray to help in climbing the solid walls, and a very queer array it must have looked.

Between the keep and the embankment they pushed through into a pocket, but counter-attacks by the 1st Guards Brigade drove them back, and the line finally stabilized for the rest of the War a couple of hundred yards or more in front of the keep. The Company bricklayers had every right to be satisfied with their handiwork.

The reorganization of the defences meant a good deal of work for the Company. A new "keep" was commenced about an orchard behind the right of the line, and a small railway triangle on the left was also strongly fortified. This point was the scene of heavy fighting on January 25th and following days, but the enemy had eventually to be satisfied with our old post B. In this affair, Parkes was slightly wounded in the head but remained at duty.

On February 2nd, the Company was relieved by the 11th (Field) Company and moved off on the 3rd to billets at Hurionville, not, however, without another catastrophe similar to that at Ypres in November, a shell bursting in the billet killing 2 and wounding 15 men. Last nights in billets began to be looked on with suspicion.

The period of rest, February 3rd/27th, was marred by a serious bombing accident in which Maj. Murray, a fine soldier, in the Black Watch, who had that day returned from England after having been wounded on the Aisne, was killed, and also a serjeant of the battalion, whilst Herring was desperately wounded, and evacuated to England. On February 22nd, Capt. E. F. S. Dawson joined as 2nd in Command.

On the 10th February, the Company received a recognition of all its strenuous efforts in the award of a D.S.O. (Lieut. R. L. Bond).

It is interesting to note that on February 11th an instruction was received that the standard fire trench was to consist of 18-foot bays, with traverses 6 by 4 feet.

On February 24th, 1 officer and 50 men (miners by trade) from the Gloucesters and Royal Welch Fusiliers joined to form a special mining section.

On February 28th, the Company moved to the old Sapper and Miner billets at Le Touret, which they were to occupy until after the unhappy attack of May 9th.

The work with which the Company was now faced was quite a new problem. The sector for which it was responsible was in the main the portion running parallel to the Rue du Bois, at one time

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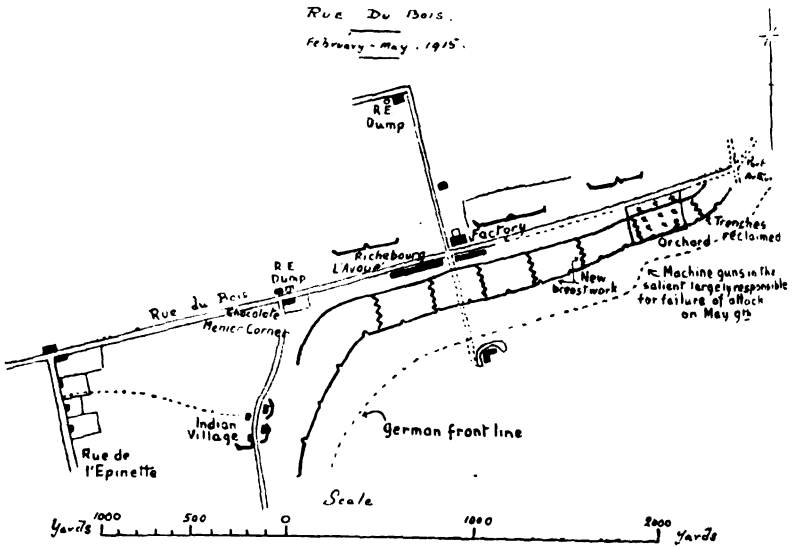
taking in Indian village on the right, at another extending almost to Port Arthur on the left. (Sketch No. 12.)

After the Christmas battle, both sides had settled down in misery in the water-logged trenches, but these became quite untenable, the water level being but a foot or foot-and-a-half below ground. The only possible shelter was breastworks. Our troops withdrew two or three hundred yards and lived in discomfort behind one inadequate line of breastworks, this being the state of affairs when the 1st Division took over the sector. The following months until May 9th were spent in a ceaseless effort to make the line defensible.

The first efforts were directed to strengthening keeps at Indian

SKETCH No. 12.



Rue Du Bois. February—May, 1915.

village, Chocolat Menier Corner, and the orchard. Then followed a great work, the reconstruction of the front line on the site of the old front trench. It was considered inadvisable to use working parties so close to the enemy, and this front line for a length of 1,500 yards was almost entirely constructed by the sappers. Complete silence and careful organization was necessary. The breastwork was, therefore, constructed as follows (see Sketch No. 13). Revetment of canvas was used in 18-foot lengths, *i.e.*, 18-foot bays, 6 by 6-feet traverses. Each length of 18 feet was made up complete with pickets. Each picket was held fast by sandbags tied to wire and buried under the parapet. Three men worked on each 18-foot length and carried their own stores, so that laying out was automatic. This system worked well, and each night a section of 30 men, the

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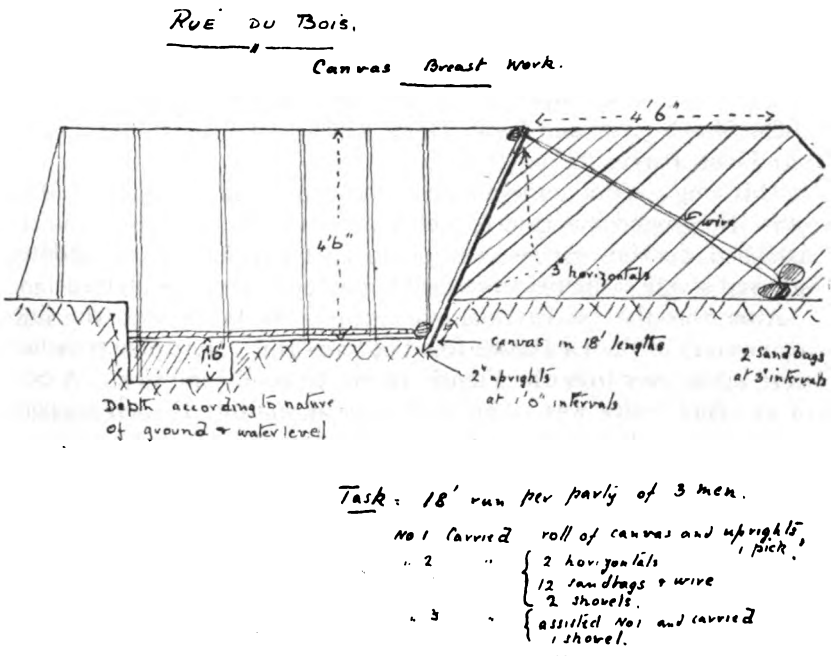
average working strength, completed five 18-foot bays with traverses. The work could not be made continuous, for the enemy soon spotted what was going on, and the flanks of completed works were unhealthy, so that eventually a long series of bays grew up, joined eventually as the situation allowed.

Once the front line was complete, it was possible to use infantry working parties on a great scale, and a very interesting time this was. Not only were there thousands of yards of communication trench breastworks to be constructed, but two series of reserve line breastworks were also required, partly with a view to the forthcoming

SKETCH No. 13.


Rue du Bois.
Canvas Breast Work.
4'6"
4'6"
1'6"
3 horizontals
Clavier
Canvas in 18' lengths
2 Sandbags at 3' intervals
2" uprights at 1'0" intervals
Depth according to nature of ground & water level
Task: 18' run per party of 3 men.
No 1 carried roll of canvas and uprights, 1 pick.
" 2 " 2 horizontals
12 sandbags & wire
2 shovels.
" 3 " assisted No 1 and carried 1 shovel.

Rue Du Bois. Canvas Breast Work.

attack. In addition, parados had also to be constructed. Every night, therefore, each sapper section (the Company worked two sections forward each night and two in billets preparing hurdles, knife-rest obstacles and so on) had some 600 infantry to handle. These were divided into four carrying parties of 50 apiece, and four working parties. The carrying parties drew hurdles from two separate dumps, and carried them to the various sites. The sappers provided sandbags and wire. Hard on the heels of the carrying parties came the digging parties. To each party a small number of sappers were allotted to do the anchoring of the hurdle revetment, and so on. As each section had parties working over an area, 1,000 yards or more long by 500 yards deep, it will be obvious that the

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guiding and R.E. supervision devolved almost entirely on the junior N.C.Os. and even sappers. That the whole work went without a hitch, the timing of the arrival of the parties being invariably excellent, is a remarkable tribute to the high standard of efficiency and self-reliance of these junior N.C.Os. and sappers. Nothing brought out more clearly what magnificent fellows the rank and file were than their handling of these rather intricate working parties.

The 23rd (Field) Company's only difficulty was to get off ahead of our friends the Lowlands each night. The latter lived half-a-mile further up the road, they had an unique gift for the construction of barbed wire knife-rests on the mass production system, and had these excellent obstacles carried out by large parties of strong men nightly. Sometimes the strong men tired of their burdens, when other users of the road would find an impenetrable block anything up to half-a-mile long, impervious to the most finished vituperator.

On March 31st, 2nd-Lieut. B. B. Edwards joined the Company *vice* Lieut. Parkes (to hospital).

This long spell of work culminated in the abortive attack of May 9th. No ground was gained, and the 23rd (Field) Company and its attached working parties, waiting to go forward and consolidate, suffered severe casualties from shell fire in the concentration trenches.

After this the 1st Division was withdrawn, going into the line again south of the La Bassée Road at Cambrin. Here new trenches were taken over from the French, in pretty good condition. A cup of excellent coffee was taken with some hospitable French sappers in the Maison Rouge dump on handing over. Mining and countermining were just commencing, making life somewhat uncertain in the line, but on the whole the sector was peaceful, the line well established, and after getting rid of the remains of the winter's mud, the work of constructing " keeps " was taken in hand on a well-thought-out principle.

These " keeps " or strong points were constructed for all-round defence, some 400 yards in rear of the front line, each " keep " intended for a garrison of from one to two platoons, and fitting in as far as possible with the existing trenches so as not to be too conspicuous.

On May 27th, Lieut. Bond was evacuated sick to England, 2nd-Lieut. Salmon joining on June 1st.

On June 1st, the Company withdrew to rest billets at Raimbert.

On June 23rd, in *The Birthday Honours Gazette*, the following awards to officers and N.C.Os. were published :—

Maj. C. Russell-Brown to Brevet Lt.-Col.
Capt. H. W. Herring, awarded Military Cross.
Lieut. J. H. Stafford, awarded Military Cross.
2nd-Lieut. A. J. Parkes, awarded Military Cross.
C.Q.M.S. Griffin, awarded D.C.M.
2nd-Cpl. Milne, awarded D.C.M.

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On June 28th, the Company once more returned to work in the line, this time in the sector to the south of their previous area. Company billets were at Labourse, two sections forward in Vermelles.

Although fighting took place constantly in the Ypres area, the front, south of the La Bassée Canal, now developed into the comparative peace of an inactive line, only to be rudely broken by the Battle of Loos.

The trench system, by the end of June, was fairly well developed, though defences were still based entirely on the rigid defence of the front line system, closely supported by a series of keeps.

The old hand-to-mouth work, resulting from the continuous fighting of 1914 and the early months of 1915, now gave place to a systematic building-up of the defences, and pre-arranged programmes with a system of daily progress reports on the model of ordinary peace construction work, into which it is not possible to go in detail. Suffice it to say that the Field Companies were now employed in the main on their true duties of more technical work in connection with bomb-proof cover, machine-gun emplacements and the construction of keeps, on a programme laid down by the General Staff of the Division. (A typical programme is given in Appendix B.) It will be admitted that this is a fairly comprehensive list. The attached mining section was, of course, invaluable in the construction of "bomb-proofs," as deep dug-outs were then called.

It should be remembered that the area in which all this work was in progress had a chalk subsoil.

On July 22nd, Lieut. Stafford left the Company for 1st Army H.Q. to take up appointment as Staff Officer to Chief Engineer, being replaced on July 23rd by 2nd-Lieut. W. R. Wilson, R.E. (Temporary Commission), who was later for so long to command the Company with distinction.

The battle of Loos took place on September 25th. For some time prior to the battle, the 23rd (Field) Company had been employed on work in preparation for the battle; widening communication trenches, making additional dug-out accommodation, spitlocking proposed forward routes and making recesses in the front line, eventually intended to hold gas cylinders. Sketch No. 14 shows the area in which the Company was employed, and points mentioned in the narrative.

The four sections moved to their battle stations on the evening of the 24th, No. 1 Section (Lieut. Edwards, 29 N.C.Os. and men), No. 2 Section (Lieut. Salmon, 28 N.C.Os. and men), No. 3 Section (Lieut. Mallins, 32 N.C.Os. and men), No. 4 Section (2nd-Lieut. Wilson, 27 N.C.Os. and men). In addition, the attached infantry mining sections were available as working parties, together with special infantry wiring parties.

Nos. 1 and 4 Sections moved partly to specially selected dug-outs

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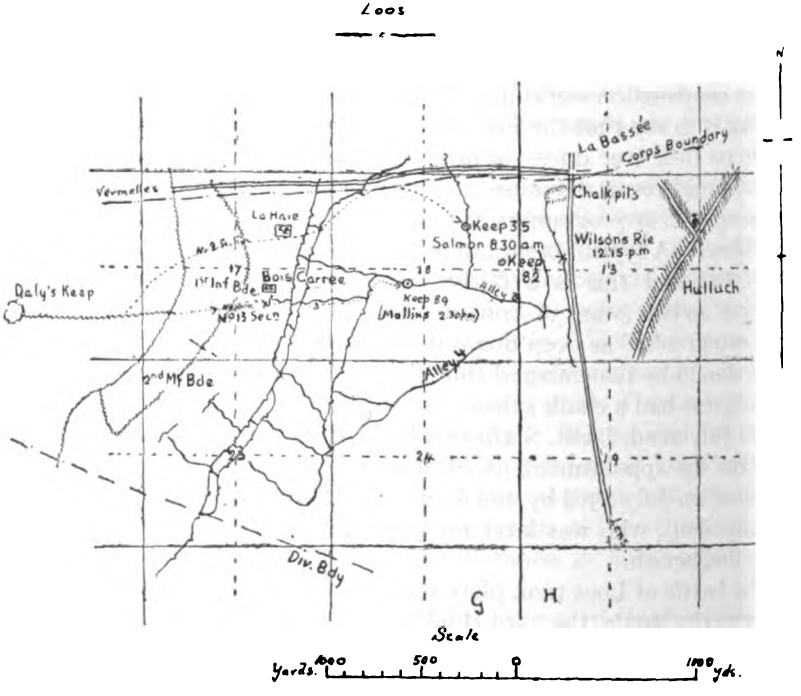
in the support line, partly into the front line, No. 1 on the right, No. 4 on the left. The men in the front line assisted the 187th Company, R.E., to place the gas cylinders in the special recesses. The gas was released at 5.50 a.m., and after rolling forward a short distance, began to drift back into the front trench. Lieut. Edwards and some 10 men were gassed, of whom Edwards and 3 men were so bad that they were unable to carry on, and had eventually to return to Vermelles. 2nd-Lieut. Wilson took charge of Nos. 1 and 4 Sections, and whilst waiting for orders to move forward, assisted in

SKETCH No. 14.



The Battle of Loos.

clearing the front line of dead and wounded. Eventually at 10.30 a.m., Wilson received a verbal order from Col. Russell-Brown, who had established Co. H.Q. in Daly's Passage: "Move forward into Hulluch and consolidate the position." This, no doubt, was the result of the following message received shortly before this from 1st Infantry Brigade: "Hulluch has been taken. Push up 2nd working party to follow the Black Watch . . . on southern border of Hulluch."

Nos. 1 and 4 Sections commenced their advance, with three infantry working and wiring parties each under an officer, at 11 a.m.

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We must now turn to Nos. 2 and 3 Sections, who were detailed to follow the assaulting troops. Both Sections moved out of the communication trench (Daly's Passage) about 7.20 a.m. and moved across country to our support line. No. 3 Section, followed by the Black Watch platoon (working party), on the right, had casualties during this movement and again in the further advance to a German T-head south of Bois Carrée, at which point the enemy's fire was heavy from front and right flank, and it appeared that the German front line was still occupied. In gallant efforts to cut the wire in front of this trench, Lce.-Corpl. Pridham was severely wounded, but Mallins followed by the remains of his Section, only 10 strong, and Lieut. McLeod and 20 Black Watch (out of 45), got into the T-head from which no advance was possible till 1.30 p.m., when Mallins led his parties forward, first to a German third line, and finally to the spot originally selected for a keep at G18 c89 (keep 89), whence Salmon's party at G18 b3.5, was visible. The party was just getting to work when a sharp outburst of fire wounded Mallins and a sapper severely. Mallins, at 3.15, had to hand over to Lieut. Wilson, who had now arrived.

No. 2 Section, on the left, having made for the Haie, at once met a party of Camerons and Berkshires moving quite steadily in the direction of our lines, having apparently completely lost direction in the fog and gas. Salmon turned them about, and an officer of the Camerons appearing and taking charge, the infantry at once went as steadily forward. Salmon waited till they were clear and then moved forward over the German front and support lines, subsequently getting into a communication trench, as casualties were being caused by rifle fire from the right. This Section, together with Lieut. Lumsden and the Black Watch working party, reached its objective at G18 b35 (keep 35), at 8.30 a.m., and at once commenced work on the strong point in spite of rifle fire from the front and left flank.

At 11 a.m., 2nd-Lieut. Wilson, with Nos. 1 and 4 Sections, as already stated, together with working parties (Lieut. Sparkes and wirers, Lieut. Mayne and 32 South Wales Borderers and Glosters and 20 Black Watch) moved out in extended order, passed south of the Haie, and having received several casualties from rifle fire from the right flank, got into the main German communication trench.

Corpl. Butler, gallantly trying to get a wounded sapper into the trench, was severely wounded but refused to be attended to, ordering Corpl. Milne, D.C.M., who tried to get him under cover, to go on. The R.E. casualties here numbered eight.

At 11.30 a.m. the whole party joined up with Salmon (No. 2 Section) at keep 35, and commenced work on the keep and fire-stepping trenches leading into it.

2nd-Lieut. Wilson, who had been ordered originally to proceed to

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Hulluch, now went forward to reconnoitre with a view to carrying out these orders, getting as far as a tunnel under the main road, about H13 a5.1, whence Wilson and an officer of the S.W.B. saw movement, apparently enemy, about chalk pits to the north. There appeared to be no British troops in Hulluch, so Wilson withdrew to keep 35.

At 3.15 p.m., touch was eventually established with the wounded Mallins, at keep 89. Steps were taken to commence joining up keeps 35 and 89 by a fire trench, and Mallins then withdrew. This work continued during the whole night of the 25th/26th. A German counter-attack against a trench running out from keep 35 was beaten off by the S.W.B.

About 8.30 p.m., on the 25th, the O.C. 23rd (Field) Co. arrived and organized the working parties as garrison of the keeps and intervening trench under the respective infantry officers.

R.E. and infantry stood to arms at 4 a.m. on the 26th.

Heavy and accurate shrapnel fire was experienced from the north during the morning, making work impossible. At 10.50, Capt. Campbell, Black Watch, in charge of keep 89, received orders to take his platoons and attack Hulluch, leaving the R.E. and attached miners only as garrison of the keeps, with Wilson and Salmon in charge. A big German counter-attack was seen in progress between Bois Hugo and Hulluch, but Campbell moved out at 11.5, under the continual shrapnel fire against Hulluch.

Through some error, the greater part of Lieut. Salmon's two sections withdrew from keep 35 about midday, a verbal order, the genesis of which was never explained, having been received for the R.E. " to pass out." Wilson, on discovering this, made every effort to get back the missing men, and eventually, thanks to the assistance of an officer of the mining sections, who was dissatisfied with the situation and returned to keep 35, all the sappers were brought back and work was commenced again on the defences at dusk.

In accordance with instructions from Gen. Ready (Cmdg. 1st Infantry Brigade), who arrived at keep 35 during the evening, Wilson and Salmon commenced work on a new keep, " 52," though actually nearer " 82," and on connections from this keep to 89. The Brigade Commander was much amused at the story of the afternoon's " retirement," which had apparently caused consternation and alarm to one of the infantry subalterns, who had been offering to shoot some of the offenders with his revolver.

At 2 a.m. the O.C. arrived with rations, and shortly before daylight all sections withdrew to Vermelles.

The casualties in this battle were 1 officer wounded and evacuated, 1 officer gassed, remained at duty, and 42 other ranks killed, wounded or missing. Amongst those who died of wounds was Corpl. Nunn, a fine N.C.O., who will be well remembered by officers who served at

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Aldershot in pre-War days as a first-rate cricketer and footballer, and a rare good fellow. He was a great loss to the Company. He was awarded the D.C.M. for his gallant example on this day.

On the 29th and 30th, the Company withdrew from the line.

APPENDIX B.

PROGRAMMES OF WORK LAID DOWN BY H.Q. 1ST DIVISION.

A. *Work to be carried out by infantry.*

* * * * * * * * *

B. *Work to be carried out by Royal Engineers.*

* * * * * * * * *

Y Section. (Note :—This was Section for which 23rd (Field) Company, R.E., was responsible.)

5(*a*) Bombproofs behind support line throughout, in proportion of one to approximately every 16 yards.
(*b*) Complete Chapel keep.
(*c*) Complete Bn. H.Q. in Y3.
(*d*) Complete blinded gaps towards Hohenzollern Fort.
(*e*) Complete Daly's keep.
(*f*) Put Le Rutoire Farm in a state of defence.
(*g*) Construction of Junction keep.
(*h*) Complete Central keep.
(*i*) Complete Le Rutoire keep.
(*j*) Continue boring for water in Y2 Section.
(*k*) Complete Hulluch Road keep.
(*l*) Construct small keep on railway near well to block railway communication trench.
(*m*) Complete tram lines to Fosseway.
(*n*) Provide water storage in all keeps.

APPENDIX C.

NOTES ON FIELD DEFENCES IN THE VERMELLES SECTOR, JUNE–AUGUST, 1915.

1. *Keeps.*

A considerable number of keeps were constructed, each for a garrison of about a platoon. These keeps were circular enclosed works, usually placed at trench junctions, surrounded by wire entanglements. Dug-outs were provided for the garrison, and the

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portions of existing trenches leading into the keep were straightened and provided with bombing blocks.

These works were naturally peculiarly visible from the air, particularly in this chalky soil, and were aptly endowed with a title of agricultural origin, owing to their resemblance to certain pastural phenomena.

2. *Concrete and tunnelled dug-outs.*

(*a*) About this time the 23rd (Field) Company constructed what must have been practically the earliest concrete dug-outs used by the British Army.

Constructed just north of the Vermelles-Hulluch Road, each dug-out was of the " cut and cover " type, with a 3-foot concrete roof reinforced with I-beams from the Vermelles brewery.

(*b*) Tunnelled dug-outs, looked on with great suspicion by the staff, were commenced. They were not allowed in the front line, and entrances had to be made under the parados of the second line. They had but 6 to 8 ft. of cover at first, but, a test being carried out by burying a 6-in. howitzer shell 18 ins. deep over the top and firing electrically, this was found to be insufficient and was increased to 8 to 10 ft. 3-in. timbering was used instead of 1½-in. and these dug-outs were then pronounced proof against 5.9 in.

A Norton tube well was installed in one of these dug-outs.

(*To be continued.*)

HISTORY OF THE 23rd (FIELD) COMPANY, R.E., IN THE GREAT WAR 1914–18. PART I.

ADDENDUM.

Appendix A. (*R.E. Journal*, June, 1928, page 218.) Order of Battle. Mounted Section Serjeant. After *Serjeant Rapson* add: " Serjeant Rapson was promoted to C.Q.M.S. and left the Company on August 13th, his place being taken by Serjeant A. Ives, who took the Section overseas."

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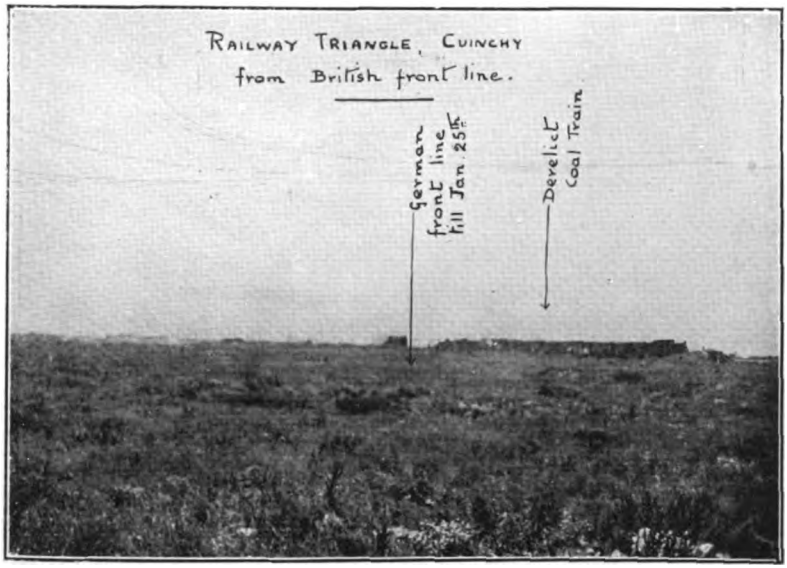
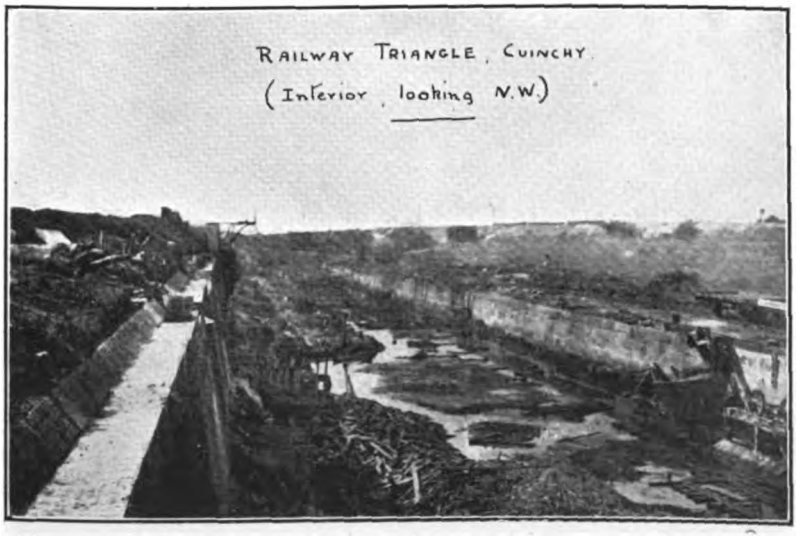
THE 23rd (FIELD) COMPANY, R.E., IN THE GREAT WAR, 1914–1918.



Railway Triangle, Cuinchy, from British Front Line.



Railway Triangle, Cuinchy (Interior, looking N.W.).

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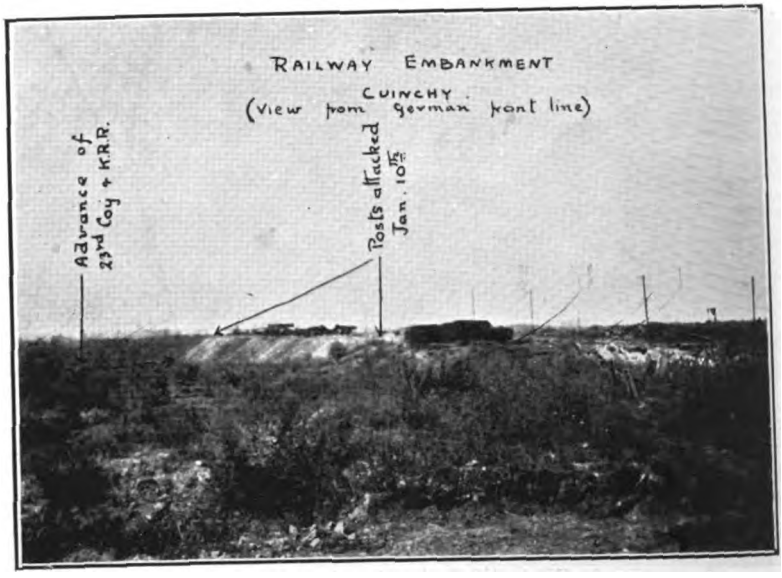
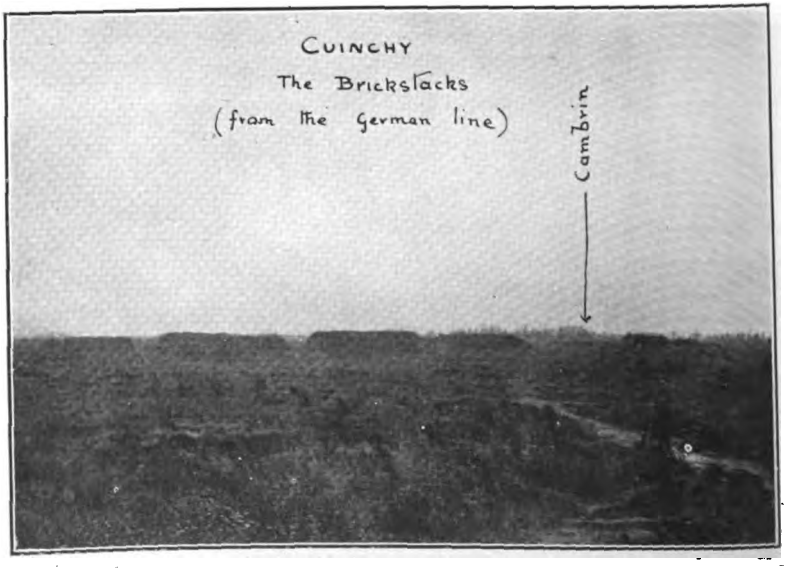


Railway Embankment, Cuinchy (View from German Front Line).



Cuinchy. The Brickstacks (from the German Front Line).

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DIPLOMACY, OR THE CONDUCT OF FOREIGN AFFAIRS.

A Lecture delivered at the S.M.E., Chatham, on October 18th, 1928, by WICKHAM STEED, Esq.

OUR subject this evening sends back my thoughts to the end of January, 1914, when I was invited to address the Royal Institution of Great Britain upon "The Foundations of Diplomacy." In those venerable precincts, devoted to the dissemination of scientific and "useful" knowledge but from which politics are rigorously excluded, it was almost unprecedented that a speaker should deal with a subject so nearly akin to politics as diplomacy. Yet I claimed that knowledge, useful and otherwise, was essential to the successful conduct of foreign affairs, and that the true foundation of diplomacy was "living knowledge in the service of an ideal." To-night, as General Walker kindly reminded me when he asked me to give this lecture, the standpoint from which diplomacy has to be considered is somewhat different. "Diplomacy," he wrote, "is always an absorbingly interesting subject, but in the normal course of events the soldier seldom has to handle it, and usually we know little about the delicacy by which diplomatic results are arrived at. When, however, the soldier is called in, it is difficult for him to give the really soundest military advice unless he is up-to-date and clearly sees what the country wants and how force could and should be used."

Here, it seems to me, we have a link between my address to the Royal Institution in January, 1914, and what I shall try to say to-night. If a soldier cannot give the soundest military advice "unless he is up-to-date," it follows that, in order to be up-to-date, he should possess as much knowledge as possible. This is another way of saying that knowledge is the corner-stone alike of good diplomacy and of good military advice.

Before delving into our subject, an instance of successful diplomacy on the part of a soldier occurs to me. Late in 1896 or early in 1897, the famous French military explorer, Colonel Marchand, was sent across Africa to explore, and to claim for France, the regions surrounding the upper reaches of the White and Blue Niles and to effect a territorial junction between the African possessions of France and Abyssinia. The object of France was—as her Foreign Minister, M. Hanotaux, confessed to me in January, 1897—to obtain control of the upper waters of the Nile so as to render untenable the British position in Egypt if England should persist in her campaign for the reconquest of the Soudan. But, by the time Colonel Marchand reached the White Nile, he found General Sir Herbert Kitchener awaiting him with a considerable force at Fashoda, now better

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known as Kodok. The circumstances were painful. Marchand had orders to go on. Kitchener had orders to stop him. Marchand had tramped thousands of miles through forest and swamp, and his escort was wholly unable to stand up to Kitchener's troops, without counting the armed steamer in which Kitchener had advanced. To have captured or to have annihilated the French force would have meant war between France and England. The British Fleet was ready for action, and the whole question was whether the French Government would accept the humiliation of seeing its design thwarted despite its representative's heroic effort. Kitchener sympathized with Marchand's position, but found him, not unnaturally, disinclined to give way. By a stroke of genius he eased the tension with a fine diplomatic phrase—" Come and have a drink."

The sequel is known to you. M. Delcassé, who, as Minister of the Colonies, had been directly responsible for sending Marchand on his mission, but who had afterwards succeeded M. Hanotaux as Foreign Minister, had the courage to recognize the mistake that had been made, and to bow to the inevitable. He yielded. Marchand was ordered to withdraw. Out of that withdrawal came improved relations between Great Britain and France which led, first, to the Anglo-French agreement of 1899 in regard to Northern Africa, and, five years later, to the Anglo-French Entente of 1904. I often wonder what the position of this country and of the British Empire would have been to-day if Kitchener had lost his head at Fashoda and had fired upon Marchand's men instead of offering their leader a drink. We should probably have had France and Germany actively against us when the South African War broke out in October, 1899, and we should certainly have found the French on the German side whenever the Kaiser might have thought " The Day " had dawned for him to strike his long premeditated blow at England.

In those days, I was living in Rome as correspondent of *The Times*. It was my privilege to be treated as a friend by one of the wisest statesmen and diplomatists I have ever known, the Marquis Visconti Venosta, who was Foreign Minister of Italy. He had been in his youth a disciple and a lieutenant of Cavour, the greatest statesman of modern Italy ; and, in the early 'seventies, he had more than once measured himself with Bismarck, not to Bismarck's advantage. From him I learned whatever I may claim to know of the principles of diplomacy, and of the proper conduct of foreign affairs. My subsequent experience, which has been varied, served to confirm the accuracy of his vision and the soundness of his principles. He it was who told me, in September, 1902, before I left Italy to take up my residence in Austria-Hungary, that he saw a great European War coming within ten, or, at most, fifteen years. " The aggressive character of German policy," he said, " will compel England to fight unless she is prepared to forfeit her place in the world." He could think of but one way of preventing this catastrophe—by creating a

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really close understanding between Italy and Austria-Hungary so that, by acting together as members of the Triple Alliance, they could jointly put a check upon German aggression. He added that no Italian Ambassador could explain this to the Austrians, for it would be too dangerous. But he thought I, as an unofficial person who knew Italy, and was about to go to Vienna, might do it in the responsible exercise of my profession.

I did my best—and failed. Failure was not perhaps due altogether to my own shortcomings, and was certainly not attributable to lack of understanding on the part of some leading Austro-Hungarian statesmen. The trouble was that Germany did not wish Austria-Hungary and Italy to agree, and that, as soon as Count Goluchowski, the Austro-Hungarian Foreign Minister, had begun to work for a good understanding with Italy, the German Emperor " torpedoed " his position ; and, further, that, by the time Goluchowski's successor, Count Aehrenthal, had learned the lie of the land, Germany had established so firm a hold over Austria-Hungary, that nothing could be done.

This is all ancient history that may seem to have little more than an episodical bearing upon our subject to-night. Yet there runs a thread of continuity between those days and the present. Partly under German influence, partly with the desire to assert their independence of Germany by mistaken methods, Austro-Hungarian soldiers and politicians conceived the idea of establishing Hapsburg rule over the Western Balkans by crushing the Kingdom of Serbia and by incorporating it in the Hapsburg realms. Now the Kingdom of Serbia was the chief independent centre of the Southern Slav race, the majority of whose members were subjects of the Hapsburg Crown. Their chief leaders dreamt of unity and independence. Some of them looked to Serbia for help. This Southern Slav unitary movement was obviously a danger to Austria-Hungary. It might have been avoided by a wise policy that would have drawn Serbia into close agreement with Austria-Hungary in such a way as to accomplish Southern Slav unity under Hapsburg auspices. But the advisers of the Emperor Francis Joseph were not wise. They lacked knowledge of the true conditions in the Southern Slav world, and they believed whole-heartedly in the doctrine of force. They were not up-to-date. When, in 1912, Serbia joined Greece and Bulgaria in a war of liberation against the Turks, the Austrians rubbed their hands, for they were persuaded that the Turks would make mincemeat of the Serbians, and that Austria-Hungary would then be able to extend a greedy, albeit an ostensibly protecting hand over the Southern Slav Kingdom, and to secure it for herself. But the Serbians actually had the audacity to defeat the Turks. They marched, moreover, across the Albanian mountains in mid-winter to the Adriatic shore at Durazzo, despite a threat that the Austro-Hungarian fleet would bombard them if they dared to reach the

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coast. At that moment, I wrote from Vienna to an important personage in London saying that if the Austro-Hungarian fleet should bombard the Serbians at Durazzo, England would have to land an army in Belgium within ten days. The reply I received from London was typical. "How are people in England," it ran, "and still more in the Oversea Dominions, to be made to understand that we can possibly have any interest in the destiny of this or that Albanian village of whose very existence most of us were, until yesterday, unaware? We can only fight for clearly defined British Imperial interests."

I will only indicate the tenor of my rejoinder—as I indicated it in my address to the Royal Institution on January 30th, 1914. It was to the effect that an Austrian attack upon the Serbians would inevitably bring on Russian intervention in favour of Serbia; that Germany would then support Austria-Hungary, while France would support Russia. Germany would at once bolt into Belgium and endeavour to seize the mouth of the Scheldt and even Calais, with a view to their conversion into anti-British naval bases. Would these developments, I asked, affect no clearly defined British Imperial interests?

Let me quote one other passage from my address to the Royal Institution:

> "More by luck than by skill Europe then escaped the worst of the dangers that threatened her. By dint of changing their policies with bewildering rapidity, the Great Powers managed to march, with imperfect alignment, not abreast but in the rear of events. When they sought to regain control and leadership, the uninformed diplomacy of some of them sanctioned expedients which were, in the summer of 1913, again to plunge South Eastern Europe into a sea of blood. Diplomacy has rarely suffered defeats more discreditable than those of 1912–1913. It failed to prevent, by timely action, the first Balkan War. It failed to prevent the resumption of that War. It sanctioned arrangements that made the second Balkan War inevitable; and its only title to honour was that it succeeded, by muddling along the line of least resistance, in staving off a European conflagration."

This, remember, I said on January 30th, 1914. Exactly six months later, Austria-Hungary attacked Serbia by way of seeking reparation for the murder of the Archduke Francis Ferdinand and of his consort at Sarajevo on June 28th. The Great War had begun. Its immediate cause lay in the persistent Austro-Hungarian misreading of the Southern Slav question, while its general cause lay in the aggressive designs which the German Emperor and his General Staff had long cherished.

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During the past year it has been my painful duty to read many of the fifty odd volumes of the German Diplomatic Documents that bear on this period. Those volumes were issued by the German Foreign Office with the object of proving that Germany was not guilty of the War, or, at any rate, not more guilty than other Powers. I admit that one effect of those volumes on my own mind has been to make me revise my former estimate of German guilt. Where I had imagined there to have been a settled, co-ordinated, scientific plan, in the execution of which German diplomatists and German soldiers were working like a well-constructed and well-oiled machine, I found that there was in reality a degree of incoherence, ignorance and uncertainty that would be almost comic had not its consequences been so unspeakably tragic. Germany, for all her planning, all her forethought, all her intrigue, blundered into the War. Neither her statesmen nor her soldiers knew what they were doing. Their objects were undoubtedly guilty, as we reckon guilt to-day, though less guilty if we accept Clausewitz's conception that war is a way of attaining political ends by other means, and that its use is legitimate for the furtherance of national interests. In the light of such a conception there is only one test of guilt or innocence in war—the test of success or failure. Judged by this test, Germany was guilty in the Great War because she failed.

Is there no other test to-day? As Mr. J. A. Spender has written in his *Life, Journalism, and Politics*:

> "No one claims credit for having planned or forced on the Great War; the victors are as much concerned as the vanquished to prove that the blame was on the other side. We now habitually speak of 'war guilt' as the greatest of public crimes, and have almost persuaded ourselves that we have always thought of war in this way.
>
> "This, it seems to me, is an illusion which we ought not to pass on to those who come after. The Great War arose out of a state of opinion which regarded war as a legitimate and normal method of promoting national interests; and to prevent opinion from slipping back into that atmosphere is perhaps the greatest task before the coming generation. . . . The truth is that, in the world in which we were brought up, the crime was not to make war but to make it unsuccessfully, and so it had been from the beginning of time. . . In my early days, Bismarck stood on the highest pedestal among nation-makers and Empire-builders, and he acknowledged that he had welded the German Empire with blood and iron in a series of carefully-planned wars. Frenchmen deplored the balance of forces which made it seemingly impossible for them to recover the lost Provinces, but few of them would have thought it a crime to wage war for their recovery, if there had been a reasonable chance of its being waged successfully.

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> "Nor can it honestly be said that we British held a different view. We considered ourselves to be pacific, but, as our neighbours pointed out, we had been more frequently at war than any of them, and the possibility of war entered into the calculations of both our political parties. . . . We might debate angrily about the sufficiency of the cause, but we never denied that, if the cause was sufficient, war was the legitimate *ultima ratio*, and not merely for the defence of territory but also for what we conceived to be the interests of the British Empire or the resentment of injuries to it."

You may ask: What have views about the legitimacy of war to do with diplomacy or the conduct of foreign policy? My answer is: "Everything." "A diplomatist," said a British diplomatist who was famous at the beginning of last century, "is a man sent abroad to tell lies for the good of his country." In this definition there was much cynical truth, inasmuch as foreign affairs have in the past usually been conducted in a rarified moral atmosphere, not to say an ethical vacuum, in which ordinary notions of right and wrong, truth and untruth, lose much of their force. There were, and are, unwritten rules and traditions that regulate the practice of diplomacy. A downright official lie is thought to be bad form, especially when it is found out; then, a dozen diplomatists may indignantly exclaim, "One really ought not to lie like that." Blundering falsehood has been frowned upon, less because it was falsehood than because it was blundering. The difference between a supremely expert and a less expert diplomatist might often be defined in the terms of the comparison once made between the methods of Talleyrand and those of Metternich. "M. de Talleyrand," said a contemporary observer, "deceives without lying; M. de Metternich lies without deceiving."

Now, if the exercise of diplomacy were confined to this sort of thing, it would deserve to rank with the less exalted but undeniably dexterous profession of thimble-rigging. But diplomacy involves other possibilities, and draws such respectability as it may possess from other assumptions. Those assumptions are that behind the words and acts of an Ambassador stands the will of the State which he represents, and that behind the State stand the people of his country, determined to give their blood and treasure in making good the claims of their Government. It is the threat of war that has, in the past, given dignity to diplomacy. Indeed, if we invert the saying of Clausewitz that war is the attainment of political ends by other than political means, we may define diplomacy as the effort to attain the same political ends without actual resort to force.

We have now to consider what constitutes effective force, for this is the real problem underlying diplomacy and military preparedness. Before 1914, it was axiomatic that the countries most strongly armed

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on land and sea would be able most easily to gain their ends by diplomacy without recourse to hostilities. It is unquestionable that Imperial Germany derived great advantages from the fact that her armies had won three successive wars—those of 1864, 1866, and 1870–71—and that her military supremacy was unchallenged on the continent of Europe. The German sabre, even in its scabbard, lent peculiar significance to the frown of a German Ambassador. "After all," said the Emperor William to an American diplomatist in the early years of this century, "nothing can prevent me from marching to Paris whenever I wish." Yet the consciousness of the possession of overwhelming force may be one of the most subtle poisons that can intoxicate the minds of rulers, statesmen and peoples. Twice, at least, in the decade before the War, Germany found her forceful diplomacy neutralized by the blunders which the consciousness of her strength caused her to commit. Once, at the Algeciras Conference of 1906 that followed upon her attempt in June, 1905, to bully England into abandoning the Entente with France, she was obliged to retreat before the coalition of strength, moral and military, which her tactlessness had created. Again, in 1911, she had to beat a retreat in the Agadir crisis: and if she compelled Russia in the spring of 1909 to yield to a German ultimatum, her triumph was gained at a price that was to render the Great War inevitable.

Even in July, 1914, the tendency of Germany to over-estimate the power of her military machine led her into courses that were to prove fatal. She had no understanding of the moral reprobation she would bring upon herself by her violation of Belgian neutrality. She knew she was doing wrong—her Imperial Chancellor admitted it—but she thought that military success would outweigh everything. By a hair's-breadth she failed; though that hair's-breadth contains the essence of our subject to-night. It shows that even the perfection of armed force is insufficient as a basis for foreign policy.

I referred at the outset to General Walker's letter, and cited his phrase that it is difficult for a soldier to give the soundest military advice, when he is consulted by statesmen or diplomatists, unless he is up-to-date and sees clearly what the country wants and how force could and should be used. Though I am even more of an amateur in questions of tactics and strategy than any soldier can be in regard to questions of foreign policy, you will pardon me if I refer to two instances of soldiers not being up-to-date and of failing consequently either to act upon the soundest military principle or to give the best military advice. I think it is generally admitted that Germany lost the War at the Battle of the Marne. Without the help of the United States, the Allies might not have won it, but they would probably have been knocked out long before America could intervene, if the Germans had taken Paris and had overrun the north-east of France and the Channel ports in September, 1914. The best explanation why they lost the Battle of the Marne was given me some years ago

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by a French officer who examined the German orders found on the field of battle after the German retreat. Those orders showed that the German General, von Kluck, swerved to the south-east instead of marching straight on Paris because of his pedantic fidelity to the principle laid down by Clausewitz that the enemy's strongest point should always be the objective of a commander in the field. He thought the strongest point of the French lay in General Joffre's unbeaten army to the east of Paris, and swerved to meet it instead of capturing the strongest point in French *moral*, which was the City of Paris, then at his mercy. Thus he exposed his flank to attack by Galliéni's " taxicab " army from Paris, by General Maunoury's Sixth Army, and by the remnants of the British Expeditionary Force. He failed to understand that, in war as in diplomacy, moral elements play a large and sometimes decisive part. Mistaken fidelity to Clausewitz was his ruin.

A similarly mistaken fidelity to Clausewitz very nearly ruined the prospects of the British Army on the Western front. I well remember an evening at British headquarters on September 13th, 1916, at the table of the Commander-in-Chief, Sir Douglas Haig. It was two days before the second battle of the Somme. With the indiscretion of an amateur, I asked some of the distinguished Staff officers present what the chances were of breaking through and rolling up the enemy line. They thought the chances good, but were not dogmatic about them. " What if you fail ? " I asked. " You can't go on for ever hammering away at entrenched positions, and losing probably more men than the enemy loses." The reply I received astounded me. It was to the effect that Clausewitz had laid down the principle that the strongest point of the enemy must always be the objective of a commander in the field ; that the enemy's strongest point was on the Western front ; and that, if the war could not be won there, it could not be won at all.

Again, as an amateur with more knowledge of foreign policy than of war, I suggested that the enemy's weakest point lay on the Austro-Italian front, and that a policy directed towards the liberation of the Austro-Hungarian peoples, most of which were friendly to the Allies, might disintegrate the Austro-Hungarian army and open the way for so successful an offensive on the Italian front, with the help of French and British troops, as to deprive Germany of her principal ally and to enable the Allies to strike at the heart of Germany through Austria and Bohemia.

My suggestions were dismissed as " politics " which had nothing to do with soldiering, and as involving a mad dispersion of forces. Yet, after the second battle of the Somme, the French offensive in April, 1917, and the British offensive towards Passchendaele in Flanders in the summer and autumn of 1917 had failed to yield a decisive result, the Austro-German forces took the offensive in their turn at Caporetto, crumpled up the Italian army, and very nearly overran the

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whole of Northern Italy. The enemy objective (as the German Commander, General von Below, afterwards confessed to Lord Cavan) was nothing less than the city of Lyons, the calculation being that, even if it were not fully attained, the French would be obliged to detach enough troops from the Western front for the defence of the Southern Alps as greatly to increase the chances of the desperate German offensive in the West, which was already being planned for March, 1918.

Why did the Germans conceive this brilliant counter-stroke? Because they felt that Austria-Hungary was disintegrating, and knew that the Austrian Emperor was negotiating secretly for peace in several directions. Therefore they took charge of the Austro-Hungarian forces, and sought to use them in a supreme effort for victory. In haste, the French were obliged to send three divisions and much artillery into Italy; and, sorely against their will, General Sir William Robertson and Sir Douglas Haig had also to detach precious British divisions from the Western front. Then, at last, those of us who were engaged in propaganda against the enemy were permitted to proclaim a policy of liberating the subject Austro-Hungarian peoples—with a disintegrating effect upon the Austro-Hungarian forces that the Italian Commander-in-Chief, General Diaz, handsomely acknowledged after the battle of the Piave in June, 1918. Had that policy been followed earlier, it is probable that the Allied armies would have had Germany at their mercy by the end of 1917.

After all, there is not much difference between soldiering and diplomacy. If either, or both, are to yield satisfactory results, they must be based on knowledge. Mere pedantic fidelity to text-books is fatal. Marshal Foch once told me that, in his belief, the secret of Napoleon's military successes lay in the immense pains he took to gather and to assimilate every detail of information—topographical, economic, political and military—that could possibly have any bearing upon the task in hand. Then, having assimilated it, he made up his mind in a flash and acted like lightning. I asked the Marshal whether he thought Napoleon would have found a way of ending the Great War more swiftly than the Allied Commanders had done. He paused a moment, and said, "How often during the War, when I passed near his tomb at the Invalides, did I not say to myself: 'Ah! You! If you could get out of your box and look at us, what would you think of us?' Napoleon would have said," continued Marshal Foch, "'What! You have telegraphs and wireless! I never had them. You have railways! I never had them. You have long-range artillery and high explosives! I never had them. You have barbed wire, machine-guns, and poison gases! I never had them. You have aeroplanes! I never had them. You have millions of men! I never had them. And, with all that, you are such lubbers as to stick here in dug-outs and trenches for years on

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end. Let me show you '—and he would have taken about six weeks to master all the new technique, all the new weapons, and their potentialities. Then, by a stroke of genius, he would have found some new dodge, some unexpected way of applying the new resources, and he would have swept over and through the enemy like a whirlwind. That is what Napoleon would have done."

Diplomacy, like war, is a method of action. But in diplomacy, as in war, the virtue lies less in the method than in the intelligence with which it is used and in the object it serves. Of the training of soldiers I know little. Of the training of diplomatists I know something. It is eminently calculated to break the mainsprings of the bright young fellows who enter the Foreign Offices of the world after stiff examinations and are then, while they are keen and eager to learn, sent to Embassies and Legations abroad—to act as typewriters to those who have too often grown grey and crystallized in the service. As soon as they have passed a year or two in one country and are beginning to know something about it, they are transferred to another country, and thence to another and another until they either become disheartened or learn to look upon the great god "Seniority" as the one source of salvation and a decent salary. A few of them survive and preserve enough elasticity of spirit to be really useful agents of their countries. Most of them become stereotyped mediocrities.

Moreover, diplomatists have nowadays little freedom of action. The telegraph and telephone bind them ever more closely to headquarters. The bulk of what was formerly the exclusive information they could obtain by cultivating the good graces of Sovereigns and powerful Ministers, is to be found in the daily Press. Yet they may, and do, discharge useful functions if they keep themselves up-to-date, understand the countries where they reside, and the countries which they represent. If they are handy with an oil can, or, in more modern phraseology, with a grease-gun, they can allay friction at a dozen delicate points of the machinery of international relations. Such work is unobtrusive, but it may be invaluable. When it is not being done, gears get heated, and dangerous breakages may occur. I could name one instance, at this moment, of an international danger that is attributable, in part, to the lack of lubricating diplomatic work; and I could name another instance in which the growth of serious international misunderstanding may be prevented because an intelligent and open-eyed Ambassador has been appointed to a certain foreign capital.

Yet, when all is said and done, the value of diplomacy lies, in the last resort, in the soundness of the policy which it expresses. In the old days, policy was the perquisite of monarchs and of a few powerful Ministers. Now it is in charge of Governments more or less responsible to peoples. In the old days, dynastic wars were possible. To-day, no great war is possible unless it have the whole-hearted support of, at least, the great majority of the people who provide the men and

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the money for it. It is a national enterprise. We know what it costs. France has so clear a vision of its nature that she has passed a law to conscript not only the persons of every man and boy, woman and girl in the country on the outbreak of war, but also their total fortunes and possessions. Thus, should war come, there could be no private profiteering and no shirking. She sees rightly that in the " next war," of which some people talk so lightly, the existence of nations and their whole civilization would be at stake. Her soldiers are thus placed potentially in the position of the executive agents of the national destiny. They cannot, they dare not, look upon themselves and their work as belonging to a special and highly technical department of public activity, but feel bound to be up-to-date and to know whether national policy is so sound as to command the allegiance of the people whose defensive efforts they would have to implement.

I say deliberately " defensive efforts," for wars of aggression are hardly conceivable in Europe under present conditions. If the late war proved anything, it showed the immense difficulty of carrying through a successful offensive even should the initial advantage of surprise lie with the aggressor. I was deeply impressed, during the early days of the battle of Verdun, by an answer Marshal (then General) Pétain gave to my indiscreet enquiry whether he would be able to stop the Germans. " In modern warfare," he said, " when an army has been given 24 hours to entrench itself, it is very hard for an offensive to succeed. We have had 48 hours. If the Germans pass, I shall want to know the reason why."

They did not pass ; and I see little prospect of any European army being able to make, with the necessary secrecy, the huge preparations that would be needed to launch a successful offensive. But the problem of defence remains, at least in theory. Defence against whom, seeing that nobody seems likely to attack ? Moreover, 50 nations are solemnly bound, by the Covenant of the League of Nations, to lend their aid, economic and military, to any one of their number who may be attacked ; and, last summer, 15 nations, whose numbers have since been greatly increased, renounced, by international covenant, recourse to war as an instrument of national policy, and abjured the use of it in their relations with each other. If these undertakings mean anything, they mean that peace, not war, should henceforth be regarded as the major probability of international relationships, and that foreign policies, of which diplomatists are the executive agents, will be policies of peace.

But do these undertakings really mean anything ? That is the question, the supreme question, on which we have all to make up our minds. Unless the peoples, whose representatives have signed the Covenant of the League of Nations and the Paris Peace Pact, are determined that those engagements shall mean something, the League Covenant and the Peace Pact may prove not to be worth the paper they are written on. But if peoples make up their minds that the

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engagements shall be kept, the civilized world, at least, may be on the threshold of a totally new era—an era in which peace, with all its implications, will become the settled condition of things, and peace, conceived merely as an uneasy interval between wars, will belong to the past.

For men whose profession is the study and the practice of war on land and sea, this question possesses peculiar interest and urgency. It involves not merely a prospect that their occupation may lose many of its attractions, but that the scale of values, in which their readiness for patriotic self-sacrifice gave them a high, if not the highest, position, may gradually be revised. Courage, and efficiency in courage, may be needed in other spheres. Soldiers and sailors cannot fail to be affected by the general transmutation of social standards which assured peace would inevitably entail.

The same holds good of diplomacy. The old conception of diplomatic action as being conducted in an ethical vacuum, with war as the *ultima ratio* in the background, would necessarily be modified. It would tend to become advocacy of national interests, with a Court of Arbitration or a Court of International Law in the background. The successful conduct of foreign policy would require, on the one hand, power of international co-ordination and, on the other, a backing of national and social peace, so that the weight of a country might tell, not by reason of its armed forces, but in virtue of its efficiency in science, in industry, in arts and crafts of every kind, and especially in intellectual and moral power.

You may think, with some reason, that I have said very little upon diplomacy and the conduct of foreign policy in themselves. The omission has been deliberate, for it is useless to dwell upon conditions which, to-morrow, may no longer exist. The old distinctions between verbal and written notes, protocols, memoranda, conventions, agreements and treaties, may vanish. I am persuaded that, should our foreign policy and our diplomacy be so bad, so out of touch with the realities of to-day and the prospective realities of to-morrow, as to involve us in another war, the whole of our present social order and even the existence of the British Empire—the most beneficent experiment in the voluntary association of free peoples the world has ever seen—would be gravely imperilled. We have no choice save to go forward prudently yet firmly. From the end of March, 1905, I saw the Great War coming. For some years past, I have seen peace coming if we have the faith and the pluck to face the risks of so high and so unprecedented an adventure. Believing this, I conceive the task of our diplomacy, that is to say of our foreign policy, as consisting in the international organization of peace abroad, and the work of our statesmen and political and industrial leaders as consisting in the organization of peace at home. True diplomacy, like true statesmanship, is founded on living, up-to-date knowledge in the service of an ideal.

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WORK OF THE R.E. WITH THE SHANGHAI DEFENCE FORCE.

(Continued from *R.E. Journal*, June, 1928.)

PART III.

Accommodation and Work of the R.E. Detachment.

As will be well remembered, the Shanghai Defence Force was dispatched in a very great hurry and at very short notice. The vital thing was to get troops to Shanghai before the arrival of the Cantonese. This was successfully accomplished, but inevitably resulted in troops being landed before adequate preparations had been made to receive them. This subsequently proved a very serious handicap on all R.E. work, a handicap which had barely been overtaken when orders were received for the withdrawal of the Indian Brigade.

All the initial arrangements for providing accommodation for the troops were in the hands of the Billeting Committee appointed by the Naval Commander-in-Chief in conjunction with the Consul-General. They had many handicaps to contend with, which, however, are really beyond the scope of this article. But, as the accumulated result of these difficulties, the huts provided, wonderful though it was to have built anything under the circumstances, were quite unfit for permanent occupation.

These Billeting Committee hutments were shortly followed by another four camps erected by the Public Works Department and the Waterworks. In each case, one was a matshed camp and one a hutted camp. These camps were rather better.

None of them, however, were ready for occupation when the troops started to arrive. They had to be kept on board ship for a few days, and then crowded into the uncompleted camps.

Such was the general situation from the accommodation point of view when the R.E. advanced party arrived. It consisted of the C.R.E., one subaltern, two foremen of works, one clerk, and two sappers. With such a staff, and in complete ignorance of the local conditions, any attempt to take over immediate control of the work was obviously out of the question. The one essential thing was to do nothing which would interfere with the provision of accommodation imperatively required. This may sound very simple, but it goes against the grain to watch money being poured into work

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badly designed for its purpose, badly carried out with bad materials. But the delay inseparable from alterations or from pulling down bad work was quite impossible. Naturally, the Chinese Contractors realized this, and made the most of their opportunity.

At this period, anyone who wanted anything turned straight to the Billeting Committee, P.W.D., or Waterworks, whichever were concerned. These institutions, having no responsibility for expenditure and wishing to do the troops well, gave everybody everything they wanted, often with the impression that they were free gifts. Such complete and unaccustomed lack of control was too much for many officers, who seemed entirely to lose all sense of proportion and responsibility, and made most unreasonable requests.

The general policy adopted may be summarized as follows :—

(*a*) To allow the three building bodies, the Billeting Committee, the P.W.D., and the Waterworks, to finish the various hutted camps they had started.

(*b*) To arrange for alterations and additions at these camps, when it was possible without causing undue delay.

(*c*) To arrange to meet the immediate requirements of the troops in the numerous billets occupied without notice or warning. At this period the only way of getting this done was to ask the P.W.D. or Billeting Committee to do it, giving them our requirements.

(*d*) Gradually to get in touch with contractors and set up our own organization for getting work done.

The time of the whole R.E. staff was completely occupied in dealing with the immediate requirements of the troops, work which admitted no postponement, and often required getting done within a few hours. Indeed, it was some time before our grip of the situation was sufficient to enable orders to be issued putting a stop to the practice, referred to above, of units giving their own orders. It was vital that there should be no delay in the provision of essentials. Most of the work was done by telephone, and at this period telephone conditions were, like everything else, chaotic.

On 8th March, the main body of the R.E. detachment arrived. 1 major, as S.O.R.E., 2 subalterns, 3 foremen of works, 1 draughtsman, 1 storekeeper, 1 clerk, 4 regimental N.C.O.s, and 3 sappers. 2 subalterns, 2 foremen of works, and 2 sappers, were left behind at Hongkong to assist there with the preparations for the arrival of the troops.

It was realized at once that our numbers were quite inadequate to deal with the urgent calls from innumerable billets and camps, scattered over the ten miles of Shanghai. The personnel left at Hongkong were called up, but Hongkong wished to keep them, and they only arrived on 21st March.

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On the 18th March, a telegram was sent to the War Office, asking for the following additional personnel :—

5 Foremen of Works.
5 Clerks.
1 Mechanist Electrician.
1 Lands Officer.
1 Inspector of Works.

These were promised, as also were two additional subalterns, and Captain Brownjohn, a first-class Russian interpreter—asked for a fortnight later.

Alarming details of the terrible hot weather were forthcoming from local residents holding responsible positions, and it was evident at once that all the existing camps would have to be largely reconstructed if they were to be fit for occupation in the summer. The overcrowding, too, was very serious, floor area being down to 30 sq. ft. per man. Either large new billets would have to be found, or large new hutted camps constructed, in all probability both.

A hut had, therefore, to be designed to meet the anticipated weather conditions and the restrictions imposed by lack of time and space. A *questionnaire* was got out and circulated to the Q. staff and Medical branch, and a definite policy to govern the design of huts was fixed. Details of this policy are given in Appendix A.

But no one yet had time to get down to the actual design of the hut. Everyone was living from day to day, and their time was fully occupied with imperative work which literally could not wait.

The standard design of hut finally adopted is shown in the attached photographs. A standard " shell " for all purposes was a *sine qua non* if the work was to be done in time. The one exception to this was a large hut for dining-rooms, canteens, etc., where such a hut was the only solution.

Two other points had to be decided at a very early date. The provision of fans and of lining for the huts, original and projected. In neither case could anything like the quantity required be obtained in Shanghai. After carrying out experiments in a hut, it was decided to get 16" oscillating desk fans. Tenders were called for from the agents of British, American, and Japanese firms. But the Japanese were the only firm who could guarantee delivery of the quantity required in the time available. They were, moreover, infinitely cheaper. An order was placed for 2,500 fans. These fans turned out a great success.

The same difficulty arose in the case of the hut lining. It became evident that the material, to arrive in time, must come from America ; and American agents quoted cheaper prices than British for the same articles. An order was eventually placed with two firms for a total of 1,000,000 sq. ft. of different types of lining. Celotex, Duro,

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Pacific, and Fiberlic, in sheets of 9′ x 4′ to fit the standard hut with the minimum cutting and wastage.

The Cantonese reached Shanghai on 21st March. The effect on the work being done by the R.E. for accommodation was as follows:

(*a*) Troops walked into numerous houses in the vicinity of the line, without any formalities. It was a tactical necessity, but naturally led eventually to large bills for damages, which it was quite impossible to check. Many of these billets had no lighting, cooking, latrines, or water arrangements; this largely increased the amount of imperative work on hand.

(*b*) A general strike was called. The Municipal Council had made adequate arrangements for maintaining essential services. There was, however, some anxiety as to possible interference with the water supply, electric light, and sanitary organization. We had to be prepared for the failure of any of them. Emergency orders were placed for incinerators and water tanks, no ready-made tanks being obtainable in the place. Fortunately, however, none of these eventualities arose.

(*c*) The general strike inevitably held up all our work. Luckily it soon ceased to be general. The possibility of a really complete stoppage of all work was, however, forced upon our notice. It was decided immediately in principle to raise a White Russian Works Company. The possibility of having to import Japanese labour was also considered. For the time being, however, no one had time to take on the job of raising the Works Company.

(*d*) Another brigade was ordered up from Hongkong. The only accommodation that could be arranged for some days consisted of corrugated iron stables with concrete floors. Fortunately, canvas beds were made available in time.

(*e*) The search for accommodation occupied a not inconsiderable time of the R.E. Staff, particularly the C.R.E. It was essential that all buildings proposed as billets should be vetted by us. Some were tumbling down and quite unsafe. It was particularly noticeable at this period how the accommodation available in a particular building was invariably largely overestimated by the "Q." staff.

(*f*) Everyone had to go about armed and in pairs. This was an inevitable drag on the work of our A.E.s and M.F.W.s, and was consequently gradually and quietly dropped. Revolvers were issued to the M.F.W.s in place of rifles.

(*g*) This state of tension and unrest continued for some weeks, but gradually things got more and more normal.

It is time to describe Shanghai from the R.E. point of view.

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The Settlement is International, with an International Council. Departments, such as the Public Works Department and Municipal Electricity Department, are almost entirely manned by Britishers, as far as their foreign staff is concerned. But they are the servants of this international body, the Municipal Council.

Everything done by the Municipal Council has to be considered in the light of other nationals. Great care has to be taken not to step on their toes. Compulsory powers for billeting or temporary acquisition of land for camps are out of the question. This has been a serious handicap throughout.

The Public Works Department run all the municipal works, roads, buildings, drainage, parks, etc., except electricity. They were most extraordinarily helpful in giving us the advantage of all their knowledge and experience. Apart from the two original camps, they took on a large amount of work for us, particularly drainage, concrete works and alterations to Municipal Council Buildings, such as schools, used for billets. They also assisted with the barricades and entanglements. Lastly, they were of much assistance in producing drawings and prints for us.

The Electricity Department were very helpful with advice, though the actual construction work was usually done by one of the many foreign firms available. As an indication of the size of the Power Station, it is estimated that the extra load due to the arrival of the various defence forces did not exceed ½ per cent. This, though we used electric light throughout, and had a number of radiators and some 2,500 fans.

The Waterworks Company is a private British Company, distinct altogether from the Municipal Council. The supply of water is ample for all conceivable purposes, and there never was any difficulty in getting connections. The quality is very good, though the doctors thought it necessary to chlorinate it, which meant the provision of tanks.

The Waterworks Fittings Company is a subsidiary of the Waterworks Company, and carries out the work its name implies. This company was very helpful when we arrived, and did much work for us, but there are several other firms probably just as good and often cheaper. The actual connection to the water main has to be carried out by the Waterworks Company.

There are numerous first-class firms of every description—foreign and Chinese—catering for all classes of work.

There is a most efficient Fire Brigade, with equipment reputed to be in advance of that of London. Fire was a serious bogey at the start, when our very limited accommodation consisted of huts packed at ten feet intervals. The only outbreak of any importance was speedily and efficiently dealt with by them.

The sewage disposal system is still chiefly by collection by *ordure*

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coolies, *ordure* carts, and *ordure* boats. It is very efficient, like most municipal undertakings, and survived the General Strike, when the consequences might have been very serious. A modern system of sewage disposal has been installed in all the more modern buildings, and is gradually being extended. It was put into one or two of our billets.

The Gas Company is a private British concern: its mains cover most of the Settlement, and there is normally no difficulty in laying on gas for heating or cooking.

The postal system is a purely Chinese affair, and shut down completely during the General Strike, when we became dependent on the D.R.L.S. This service had great difficulty in locating Chinese addresses, and a Chinese chit coolie had to be taken on. Even after the strike the postal system was very uncertain, and numerous letters took days in transit or were never delivered. The Command Paymaster had to send his cheques to the C.R.E.'s office, where contractors were directed to call twice a week.

Before leaving this aspect of the subject, a few notes on the Engineer resources of the city must be included. It has already been pointed out that the supply of water and electricity is ample for all possible military purposes.

The supply of other materials was equally abundant in almost every case. The 700 odd huts erected made not the slightest impression on the vast stocks of timber in the place. There was never any fear of any shortage of hardware of all kinds. Stoves of any pattern can be cast locally in quantities. The only materials for which special arrangements had to be made were hut lining and fans. These have already been referred to, as has also the lack of ready-made water tanks. Turning to essential defence stores, all sandbags had to be imported, but some thousand tons of barbed wire, a rusty relic of the Great War, were found in the city and were purchased at a twelfth of the vocabulary price. There was never any difficulty in obtaining wooden pickets. Suitable wire cutters were, however, hard to come by.

As regards labour in normal times, practically unlimited numbers of Chinese are available of every trade. They are extraordinarily quick workers, and work from 12 to 14 hours a day. Rain, however, completely puts a stop to all work.

Besides Chinese, there are a number of Russian labourers in the place. In case there should be a complete failure of Chinese labour, a number of these Russians (35) were taken on as day labourers, and arrangements were made to form a Russian Works Company, should the necessity arise. All details were worked out, and Captain Brownjohn, a first-class interpreter in Russian, was made available to command it. Russian labour is, however, rather expensive as compared with Chinese.

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The geographical and climatic conditions at Shanghai have an important influence on all constructional work in the place.

The city is built on the mud flats of the alluvial deposit of the Yangtse, the natural level of the land is practically flush with or below high water mark. Consequently all land has to be raised some two or three feet before it can be used for any purpose whatever, other than agricultural.

Drainage is a great difficulty, particularly if heavy rain coincides with high water. As much as three inches may fall in an afternoon, and many streets are then flooded.

Typhoons are another worry, about which much was heard. Actually, they very rarely strike Shanghai, and none of the buildings have any typhoon protection, as at Hongkong. The only serious danger is to junks on the river. In 1927, the typhoon gun was fired once, but the typhoon curved away. In the remote eventuality of a typhoon striking the place, all matsheds, including the aeroplane hangars, would of course " go west."

Much was also heard in the early days of the appalling summer. June 15th was the date when conditions would get really bad for three months. This was an extraordinarily accurate forecast as to date, but the heat never got as severe as expected ; the temperature never exceeded 100°. The humidity, however, is very high, and the minimum at night, too, is high, seldom falling below 80°. It was trying in buildings ; without fans, the huts would have been unbearable. The weather changed for the better in the first week of September, when the maximum temperature fell to the 70's and the minimum to the 60's.

On the arrival of the force in February and March, it was very cold and wet : often frost and ice at nights. There was a very dry spell from 1st May to 15th June, which materially helped the building of the huts. This was followed by a fortnight's heavy rain. In July and August, there was comparatively little rain, except for heavy thunderstorms, but it was very humid. Protection against lightning must be carefully watched—one house was struck within twenty yards of the Field Company's gun-cotton.

The numbers for whom accommodation had to be provided reached their maximum at the beginning of June, when the total rose to 16,762 comprising some 70 separate units, depots, etc.

Some statistics as to how this accommodation was found will emphasize the extent of the work with which the R.E. were faced.

Dealing first with billets, these comprise :—

1 hotel and 3 blocks of flats.
14 Municipal Schools.
38 offices and shops.
40 godowns and factories, varying from a size sufficient for one battalion to a size sufficient for one platoon.

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89 private houses.
16 miscellaneous properties, among which may be mentioned the Race Club Stand, and stables, 3 dance halls, 1 Turkish bath, 1 amusement palace, 1 jail, 1 theatre, 1 riding school, 1 gymnasium, 2 police stations, and a fire station.

Turning to huts, these were erected in 35 different localities, and comprised :

269 standard huts erected by the Billeting Committee. All of which had to be substantially altered by the R.E.
274 standard 20′ huts, R.E. pattern.
12 standard 35′ huts, R.E. pattern.
193 miscellaneous hutted shelters for cookhouses, bath houses, ablution shelters, latrines, etc.

Hospitals inevitably were a source of difficulty. For the British General Hospital, a newly-built block of flats with every modern convenience was rapidly converted into a first-class up-to-date hospital. A brand new school was used as an overflow. The Indian General Hospital was in a piano factory, overflowing into huts. A dance hall and an old tumbledown school, overflowing in each case into huts, were used as isolation hospitals. The latter, the original home of the hospital for the first troops landed, was a most unsatisfactory affair.

Mention must be made of the ammunition huts. When first required, there was literally no suitable site above water level available. Large grids 3 feet high were built of 10″ x 10″ and 12″ x 12″ timber, which happened to be at the site, and was lent by the Lumber Company. Corrugated iron sheds were built on the top. Six months later, the Lumber Company wanted their timber back. It had to be bought at a cost of some £2,000, with, however, an undertaking to buy back later.

Godowns were used for Ordnance and Supply Depots. Ground was rented and filled for the R.E. Stores, and a hut and sheds built.

No pier work had to be done, though one for ammunition was asked for. It would, however, have been a big job.

Very little space was available as parade grounds or football grounds. Great difficulty was experienced in obtaining suitable sites even at fabulous rents.

Hundreds of thousands of tons of earth filling had to be carried out at the various sites selected for hutments and other purposes. This earth had to be covered with thousands of tons of ashes.

Taking the different categories of accommodation in turn, the R.E. work involved will be outlined in greater detail.

Billets of all sorts were always the most troublesome. Each billet

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was different from any other, and consequently required special treatment in each case. There being no terminal contractor and no possibility of getting one, each separate job had to be put out to tender. At the start, all jobs were rush jobs ; there was never any time to call for competitive tenders in an orthodox way ; a contractor had to be " caught " who would take on the job ; he was asked verbally or on the telephone what it would cost, and in 99 cases out of a hundred his figure had to be accepted. At the very start it was even worse ; the P.W.D. or the Billeting Committee were asked to get the job done without any discussion as to the cost.

Billets more often than not were either empty houses on the point of being demolished for rebuilding or brand new buildings just approaching completion. No other empty buildings existed.

The old houses were most depressing places, and usually required complete water installation for all purposes and complete rewiring for light. Often portions of the building had to be propped up or extensive repairs done to the roof.

The new buildings were usually left in the hands of their original architect and contractor to finish according to our wishes. This policy had much to say for it, and was really inevitable, but the work put in was often badly designed, badly executed, and invariably very expensive.

One large building had an extra storey added on the roof. In the absence of sufficient staff to take on this job, one of the leading architects in the place was commissioned to do it all. Details of design and standard of work were surprisingly poor, and the cost most excessive.

The original huts, erected by the Billeting Committee, required drastic improvement.

They had been built on a wooden frame resting straight on the ground without any foundations of any sort, or any form of ventilation. The ground between the huts had then been ashed to make it passable in wet weather. As a result, water accumulated under the huts, and many of them were almost afloat. It was found by experiment that they could be levered up as they stood, first one side, then the other. They were all raised in this manner 18 inches, and supported on short blocks of 10″ x 10″ timber resting on a reinforced concrete foundation. The water could then be pumped out and the ground underneath levelled up with ashes.

Four to eight extra windows had to be provided in each hut, also louvred ventilators in each gable end.

The huts had to be lined, and wired for electric fans.

A complication was caused by the failure of one of the contractors to produce the hut lining to time. In one camp three-ply wood was therefore used, in another beaver board, but the majority of these old huts were lathed and plastered. The serious objection to this

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latter method was the necessity of emptying the hut for five days or a week.

The original kitchen and latrines built were condemned by the Medical Authorities, and had to be completely scrapped and rebuilt. Great importance was attached to making everything flyproof, and to putting down concrete floors for cleanliness on a most liberal scale, not only inside but outside these buildings.

In order to make more air and light, a number of huts had to be removed altogether. Most of them were cut up into sections and re-erected on neighbouring sites, often made available by the removal of redundant stables.

The outstanding point in the erection of the new huts was the great difficulty experienced in proper supervision, even when a number of additional civilian clerks-of-works had been taken on and every available R.E., N.C.O. and Sapper, employed on this particular job.

The contractors had seen the bad material and work put into the original huts. They based their prices for the new huts on the assumption that we should accept similar work and material. They knew we were building against time, and work was being done day and night.

Much timber had to be forcibly removed and destroyed before they could be induced to use reasonably good material.

Tenders for additional huts went up 10 to 15 per cent. as a consequence.

In addition to the bare huts, separate contracts were required in each case for electric wiring and fittings, hot and cold water system, and drainage. Owing to the dead-flat low-lying ground surface, drainage was always essential. Fire hydrants were also installed in many cases.

In addition to billets and hutments, there was a large amount of miscellaneous work.

Some eight or ten tented camps were erected. These had all to be provided with the usual camp accessories, but on a more elaborate scale than is customary, owing to the camps being occupied for months on end, and the consequent medical requirements. Hundreds of yards of duckboarding were also necessary.

Two steam sack disinfectors were obtained, made to the rough designs of the medical authorities, but only one was ever put up.

Four large matshed hangars were erected on the temporary aerodrome. One collapsed shortly after erection, owing to interference with its foundations by the Waterworks Company when putting in fire hydrants and mains. No damage was done to aeroplanes, and the Company paid for its re-erection. Each hangar could take six machines.

Matshed cover was also provided for dumps of hay, horse standings, gunsheds for the artillery, and as protection for the armoured cars

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Matsheds are erected very quickly by local contractors, but only last about six months without repair.

It is time to revert to the question of personnel and its organization.

From the 22nd March, Shanghai was divided for R.E. purposes into an Eastern and Western Area, each with two Assistant Engineers, and three or four Foremen of Works, but no clerk, draughtsman, typewriter, or books of reference.

There was no Officer i/c R.E. Stores, and so everyone had to buy as best they could. The stores at this period were to all intent and purposes non-existent. An account of the growth and development of the stores follows in Part 4.

All financial work and billing was concentrated in the C.R.E.'s office.

A list is attached in Appendix C showing the additional staff, which it was found necessary to engage locally. But this staff knew nothing of military methods and practices, and the actual dealings with the troops had to be left in the hands of the military personnel, who for three months worked 16 hours a day, seven days a week.

The welcome arrival of Lieut. Palmer, five Foremen of Works, five Engineer clerks, and one Mechanist Electrician on 30th May came just in time to save a complete breakdown of the original staff, many of whom had had to retire to bed for short rests.

On 20th June, Captain Brownjohn arrived from Hongkong, after handing over to a relief sent out from England. In addition to taking over the directly employed Russian labour, he was appointed Officer i/c R.E. Stores, and made responsible for the R.E. Serjeants' Mess.

With the arrival of these reinforcements, the place was divided up into three areas instead of two, the locally-employed staff was gradually reduced, and work generally assumed a more normal aspect. Further, it became possible to give officers, W.O.s, N.C.O.s, and men a holiday and rest at Wei-hai-wei.

The last reinforcement, Lieut. Evans, arrived to take up his duties as Inspector of Works, on 21st August, when most of the billing work had been finished. On his arrival, notice was given to the Civil Assistant Engineer who had recently been employed on this work.

In the middle of June, O.C.R.E., Tientsin, asked for the assistance of one officer to help with the arrangements at Wei-hai-wei, where a Convalescent Depot and a battalion for guard duties were being established. No works officer being available, Lieut. Ray, of the 10th (Field) Co., Q.V.O. Madras Sappers and Miners, was sent up on 20th June.

Two points, which were of great assistance to the detachment sent, were the posting of Sappers as officers' batmen, and the number of motor bicycles allowed.

The Sappers, in addition to acting as officers' batmen, were

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employed during the rest of the day in various capacities, as clerks, as assistant foremen of works, supervising work being done by contractors, as blue-printers, and as chauffeurs for the sidecars obtained locally.

The motor bicycles provided were invaluable, but even so, additional motor transport had to be obtained, namely, three motor cars and three sidecars, one for each of the three divisions.

The four regimental N.C.O.s were also of great value. In the first place, they were employed on the defences, being attached to No. 10 (Field) Co., Q.V.O. Madras S. & M. Later, they assisted the various A.E.s and in the stores as required.

Another point, which would have greatly facilitated work, would have been the provision of complete offices, not only for the C.R.E., but for the stores and the three divisions. Without a *Barrack Synopsis, Design and Construction of Military Buildings, Drainage Manual, W.O Pattern Book, D.F.W.'s Circular Contracts*, Type Plans and detailed drawings of standard type huts, etc., an officer in working out a design for some work is limited to his own experience and imagination, instead of being able to draw on the experience of others over a long series of years, as expressed in the various publications mentioned. Moreover, it takes him a day to do what should take him only an hour. Working drawings of huts were cabled for on the way out; in their place, proofs of the plates destined for *M.E. Vol. VII, Accommodation*, were sent; these were useful up to a point, but the detailed drawings asked for would have been infinitely more so. It is difficult to think of and work out every detail satisfactorily, when every other minute one is being interrupted by urgent demands for jobs to be carried out immediately in many different places. It must necessarily be much better done in peace and quiet, away from the rush of urgent work.

In conclusion, a few words on the financial side of the work will be of interest.

In six months, nearly 1,000 bills totalling more than £250,000 were passed. For the first three months, only two clerks were available, who had also to cope with all the other work of the C.R.E.'s office. A civilian stenographer was engaged, and eventually an Inspector of Works, but naturally he knew nothing of army forms, method or regulations. Only the understanding sympathy of the Command Paymaster and Financial Adviser made it possible to pay any bills at all.

PART IV.

THE R.E. STORES.

The Stores were opened on 28th March in a corner of the S. & M. Company Camp at Ward Road by Q.M.S. Morris, his staff consisting of five Chinese coolies, of whom one was, theoretically, English-

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speaking. Q.M.S. Morris had taken the precaution to leave England with a portmanteau full of the essential store-keeping forms; also at one of the intermediate ports he carried out a raid on the local R.E. Stores office, resulting in the capture of ledger-covers and sheets. Consequently, he was able from the beginning to keep his books in the correct manner, and when the audit staff appeared in July, they were considerably astonished to find all transactions properly recorded.

For the first few weeks, the stores dealt with were mainly for defence, large numbers of sandbags, coils of barbed wire, and Foochow pickets being distributed to almost every part of the Allied Front. The ledger-keeping was done at night in a corner of the A.E.'s office. In the middle of April, the R.E. Yard was properly fenced in, and two C.I. stables converted into more or less burglar- and weather-proof storehouses.

A large selection of tools had now to be obtained by local purchase, to supplement the tools of the S. & M. Company and to equip the Russian direct labourers. The staff was at this time increased by the addition of one European Serjeant and one Sapper, and one Indian Sapper, who all did excellent work, though without any previous experience of stores.

A stock of maintenance stores of every description was gradually accumulated, purchases being made at first entirely through the P.W.D. On the arrival of Captain Brownjohn and a Q.M.S. clerk in June, purchasing by local tenders for all except Ordnance Stores was begun in order to relieve the P.W.D. of the extra work thrust on them, and also to simplify our financial dealings.

In July, an office and storehouses were constructed, on a site opposite the S. & M. Company Camp, to the relief of all concerned. The old stores took up much space in the S. & M. Company camp; yard space was practically non-existent, and the tin-roofed office a perfect inferno during the day. In August, the task of installing the stores in the new premises was tackled, Q.M.S. Morris being sent to Wei-hai-wei for a much-needed holiday.

Up to date, the total number of transactions has been 2,303, made up of 522 receipts and 1,781 issues. The number of store bills has exceeded a total of 150, representing an expenditure of £20,000 approximately. The space occupied by the Stores measured 57,000 feet super, of which 7,600 were office and store accommodation, the balance being yard.

The experience gained points to the following:—

1. A full staff should be on the spot from the beginning to prevent breakdowns in health through overwork and to ensure economy in the issues of stores.

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2 Where much local purchase is to be resorted to, an officer in charge should be sent; the S.O., R.E., on whom the purchasing duty otherwise devolves, is fully occupied with other duties.

3. A reserve of tradesmen's tools should be sent out by Ordnance with the Force. Apart from the possibility of the employment of direct labourers not in possession of their own tools, as was done here, a Field Company's tools are not sufficient when the whole personnel are turned on to construction work.

Complete chests of tools are not required so much as a supply of the more commonly used tools, *e.g.*, saws, hammers, planes, etc.

PART V.

MEMORANDUM ON ACTIVITIES OF LITHO. PRINTING SECTION, R.E.

The Lithographic Printing Section was mobilized on Sunday, 23rd January, 1927, at the Ordnance Survey Office, Southampton. It consisted of a total of 12 men, of whom the senior was Sjt. Prudent, R.E. The trades were as follows:—

6 draughtsmen.
3 litho. provers.
2 ordoverax workers,
and 1 photographer.

The equipment consisted of

1 quad crown hand press fully equipped.
1 ordoverax outfit,
also dry plate photo 5 x 4 field and copying camera.

The stores brought out were considered sufficient for three months for all the above processes.

Stores and equipment were loaded on Friday the 28th on s.s. *Kinfauns Castle*, and the Section embarked the following day. Shanghai was reached on the 8th March after trans-shipping at Hongkong on to s.s. *Kamala*. The strength of the Section was further increased early in June by the arrival of four draughtsmen R.E. and one clerk.

To start with, stores and equipment were placed in a shed, but after about ten days a suitable workshop was discovered, and work was able to commence. As there was no Survey Officer with the Section, it worked directly under the G.S.O. (3) in I.

As ever in these cases, the work was heaviest at the beginning, draughtsmen's work in particular being very heavy. One job

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involved the printing of a thousand copies of a map in three colours, *i.e.*, three thousand printings. This took no less than from the 7th April to the 9th June, and demonstrated quite clearly how extremely heavy and exhausting is a hand-operated quad crown press. Work in general, however, consisted in small jobs, blue prints, and ordoverax for C.R.E., C.R.A. (*e.g.*, panoramas from O.P.s, etc.), and small sketch maps for the General Staff. Later, there was a fortnightly situation map.

The following difficulties were encountered, all climatic :—

As the summer advanced, the hot weather became very trying, and it was extremely exhausting working the hand press.

The humidity was very high indeed—75%, 85%, and even over 90%—which led to every kind of trouble with paper and all the processes.

Difficulty was encountered at all times in working the ordoverax, and by the commencement of June the process had to be abandoned altogether, and vandyke took its place, although the Section was not properly equipped for vandyke.

The sun is by no means dependable in this climate, and for days, almost weeks on end, there was little or no opportunity of blue printing in the Section, as no artificial light was available in the equipment.

After the first alarms and excursions of March had died away, so automatically did the demands on the Litho. Section become less, and from June onwards there was very little work.

Map distribution was undertaken by two N.C.O.s of the Section who were draughtsmen, and who were, therefore, able to continue their work in the map room.

PART VI.

Work of the Army Postal Service.

The Army Postal Service in China had to function under severe difficulties during the period immediately following the arrival of the Force in the early days of March last. An advance party left the U.K. on 29th January, 1927, and arrived in Hongkong on 28th February, to find that the S.D.F. was split between Hongkong and Shanghai, although all the mails had, in accordance with information received from the War Office, been consigned to Shanghai. Arrangements had to be made, therefore, for the mail boats to be boarded in Hongkong, and for the whole of the S.D.F. mails to be gone through there, in order that matter for the troops in Hongkong could be selected and the remainder of the mail sent to Shanghai. A similar arrangement had to be made later at Shanghai, as regards the mails *via* U.S.A. and Canada, the mails for the troops in Shanghai being selected, and the remainder of the mails being sent to Hongkong. Gradually, as units were brought up from Hongkong to Shanghai, the

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position became fairly stable. Units were located in Hongkong, or Shanghai, as the case might be, so that through mails no longer had to be tapped at either place.

The retention of R.A.S.C., R.A.O.C., etc., personnel at Hongkong necessitated a certain amount of sorting from nominal rolls.

The sending of details to Tientsin and Wei-hai-wei, of course, complicated matters, but no serious difficulties in this connection arose.

As a matter of interest it may be stated that the arrival of the main party of the R.E. Postal Section in Shanghai coincided with the beginning of the Chinese postal strike. This proved to be a fortunate circumstance, as it was possible to provide the civilian European population with an emergency postal service which was much appreciated. About 16,500 items for all parts of the world were posted by civilians during the emergency period, and incidentally, the amount of about £200 was added to British funds.

A statement is attached in Appendix B showing the volume of work dealt with during the period April to July inclusive. The postings were surprisingly heavy in proportion to the size of the Force. The average weight of a bag is half-a-hundredweight, so that the average weight of mails dispatched monthly was about five tons.

Letters and newspapers superscribed "*via* Siberia" arrive at their destination in either direction in about 20 days, those sent *via* U.S.A. and Canada in about 26 to 28 days, and those sent *via* Suez in about 34 days.

APPENDIX "A."

DECISIONS GOVERNING DESIGN OF HUTS.

1.	Floor area per man	50 sq. ft. as against 80 laid down for South China and 70 for North China.
2.	Cubic space per man ..	600 cubic ft. as against 1,040 laid down for South China, and 770 for North China.
3.	Distance apart of beds ..	6' centres.
4.	Spacing of windows ..	1 to every 2 beds.
5.	Stoves	2 per hut.
6.	(*a*) Shelving	3ft. per man.
	(*b*) Coat pegs	3 per man.
7.	Arm racks	In men's huts, suitable for locking by sections if required (actually, locking apparatus was never issued).
8.	Internal lining to huts ..	To be supplied.
9.	Verandahs	Asked for by medicals, but not provided owing to lack of space.

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10.	Flywiring	To be provided in cookhouses, dining-rooms, and bread and meat stores.
11.	Ceiling or double roof ..	Double roof, *i.e.*, internal lining on rafters.
12.	Distance apart of huts ..	Twice the height of the eaves (actually it usually has to be less).
13.	Provision of electric fans ..	In all huts, and in all offices and cookhouses.
14.	Accommodation for field officers	One room.
15.	Men's dining-rooms	To be provided for half battalion at a time if space was short.
16.	Officers' Mess	Anteroom, Messroom and offices.
17.	Serjeants' Mess	Messroom and offices.
18.	Kitchen	On synopsis scale.
19.	Baths	7 or 8% showers, 1% slipper.
20.	Waterborne sanitation ..	In exceptional cases only.
21.	Chlorination	Water tanks sufficient for one day's supply of drinking water at a gallon a man.
22.	Offices, stores, guardroom, etc.	On synopsis scale as nearly as possible.
23.	Horse standings	Hard standings and matshed covers.
24.	Recreation Establishments..	On synopsis scale as nearly as possible.
25.	Drying rooms	To be provided.
26.	Medical inspection rooms ..	To be provided.
27.	Sheds for guns, etc. ..	To be provided.

APPENDIX "B."

Return of Work, Army Post Offices, S.D.F.

	April.	*May.*	*June.*	*July.*
No. of bags of mail received ..	282	362	498	516
No. of bags of mail dispatched	141	146	220	278
No. of registered items received	713	894	1168	1088
No. of registered items dispatched	718	830	1139	1140
Amount of sales	£1,582	£1,873	£1,566	£2,329

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APPENDIX "C."

SUMMARY OF CIVILIAN ASSISTANTS.

Appointment.	*Salary.*	*Total Numbers Employed.*	*Maximum Numbers employed at any one time*	*Total Men Weeks.*	*Remarks.*
Assistant Engineer ..	$400 per month = £50.	3	3	52	Includes P.W.D. Liaison Officer. One A.E. acted as Inspector of Works for two months.
Foremen of Works ..	$80 per week = £8.	6	5	85	
Russian Supervisor ..	$70 per week = £7.	1	1	21	Still employed with Russian labour.
Draughtsman	From $40 (£4) to $140 (£14) per month	5	3	54 (up to 30/9	Two still employed.
Typist	One at $200 (£20), One at $100 (£10) per month	2	1	21 (up to 30/9)	One still employed.
Messenger and Cleaner	$3.50 per week = 7/-.	1	1	22 (up to 30/9)	Still employed.

N.B.—The staff of the Billeting Committee (1 Secretary, 1 Clerk, 1 Messenger) are *not included* above

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THE R.E. WITH THE SHANGHAI DEFENCE FORCE.

Pile driving.

A heavy load.

Contractor, foremen, and ground frame of R.E. Standard Hut.

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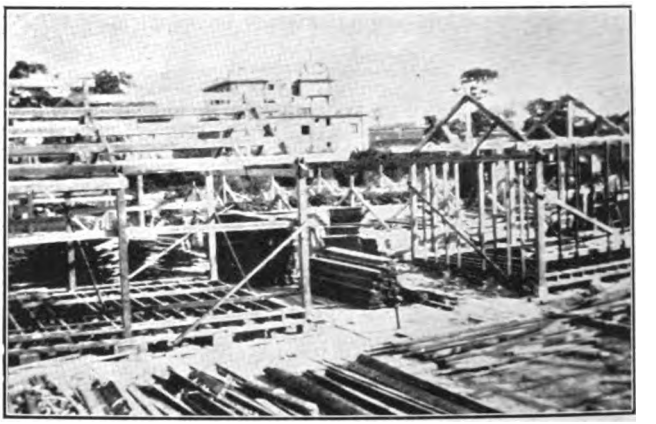
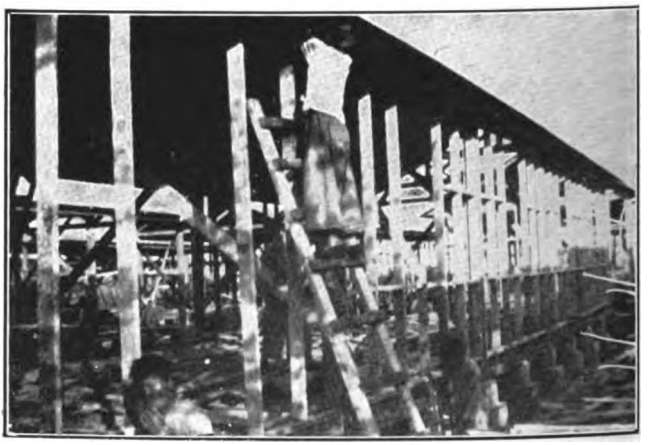
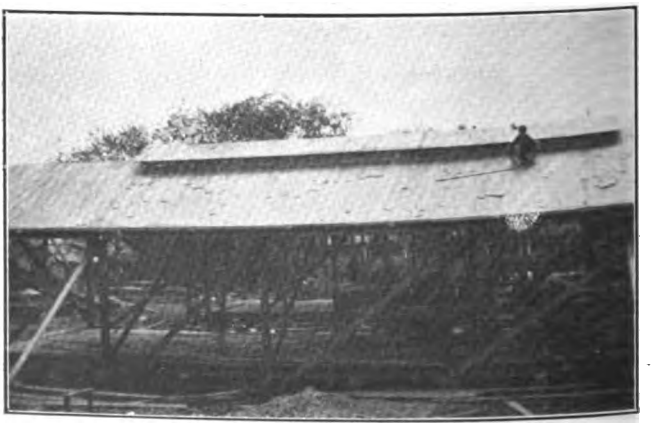


R.E. Standard Hut under construction.



Fixing wall studding.



Boarding the roof.

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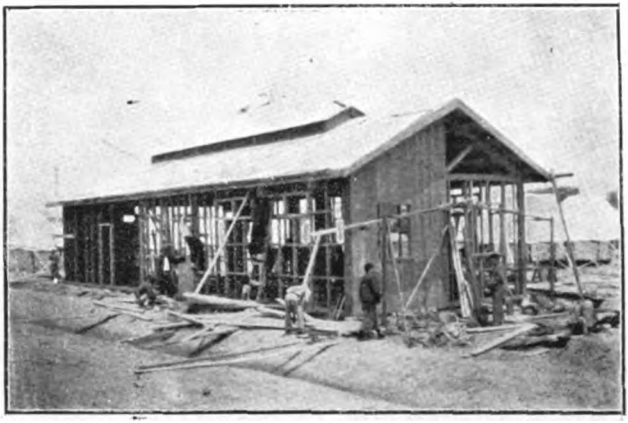

Fixing wall boarding.

Exterior of completed hut.

Interior of completed hut.

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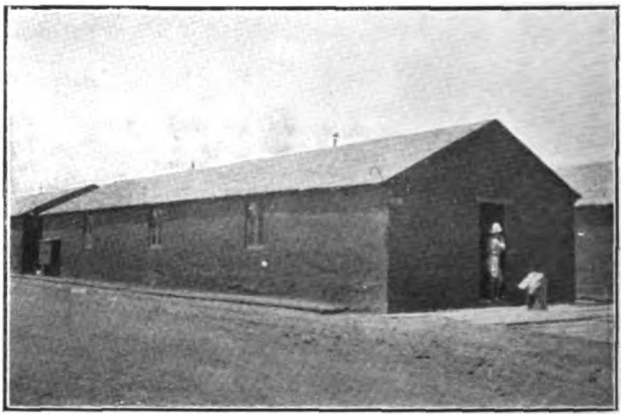
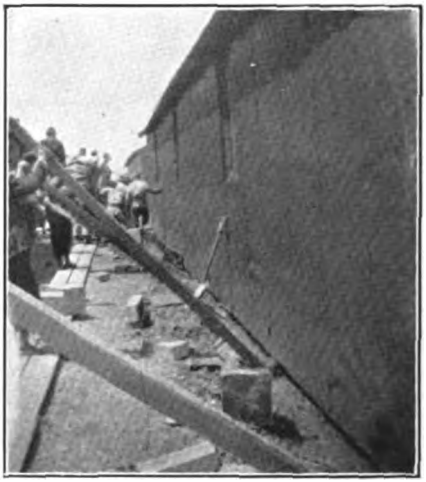
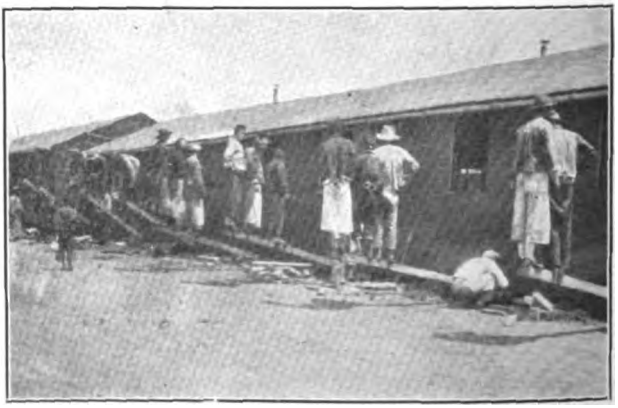


Standard "Billeting Committee" Hut.



Levers in position for raising.



Raising by "walking the plank."

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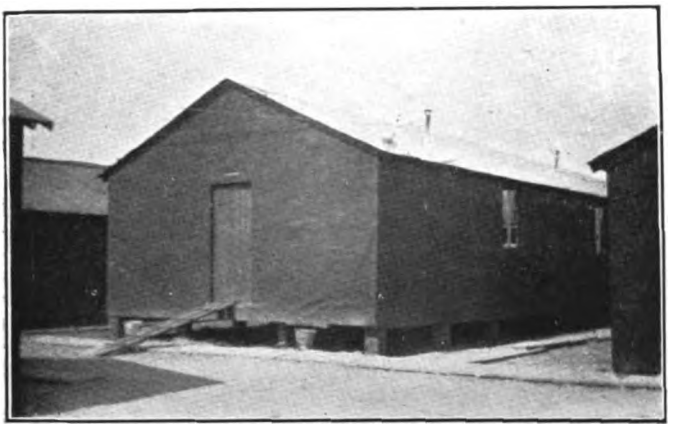
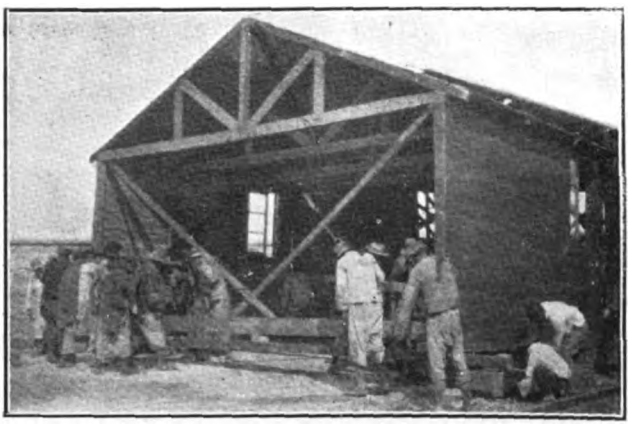


The hut raised.



Cross-strutted ready for moving.

On the move to new site.

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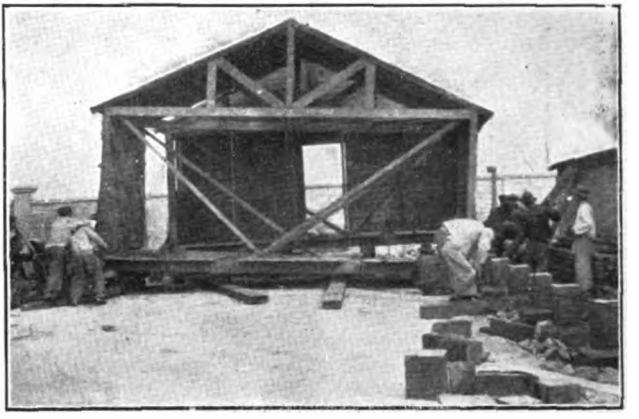

Joining up at new site.

Matshed hangar under construction.

Hangar completed.

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OVERLAND TO INDIA.

By Lt.-Col. H. T. Morshead, d.s.o., R.E.

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Introduction.

The following notes have been compiled by one who has recently accomplished the overland journey to India, in the hope that they may prove helpful to any others contemplating this easy and highly interesting alternative to the stereotyped sea passage to or from Europe.

The title, " Overland to India," is not strictly accurate, since the last break of the journey was made by sea from Basra to Bombay. In order to complete the journey wholly by land, it would be necessary to buy (or hire) a car in Baghdad, and drive oneself 1,000 miles or so across Persia to the Indian railhead at Dusdap or Quetta. In the following article it has only been possible to record a few general impressions of the journey, together with such items of information as may assist intending travellers in planning their route. Fuller details regarding the countries traversed may be obtained from any of the published handbooks ; of these, *Cook's Traveller's Handbook to Constantinople, Gallipoli and Asia Minor* (price 6s.), and *Cook's Traveller's Handbook to Palestine, Syria and Iraq* (price 10s. 6d.), are the most up-to-date and should suffice for most purposes.

I.—London to Constantinople.

Sunday Morning, 27th November.—The London fog, so murky and yellow that one cannot see across the road ; flares are blazing here and there at street corners, and my taxi can only move at a slow crawl, with its lamps switched on. Punctually at 11 a.m. the Continental Boat Train leaves Victoria Station. As we leave the great city behind, the fog lightens somewhat, revealing glimpses of the trim fields and hedgerows of the Weald of Kent. On this dull morning, however, the personalities of my fellow travellers in the comfortable pullman saloon form a more intriguing subject for study than the fleeting panorama of the " Garden of England," half visible through the clouded windows of the train. A few pairs of skis in the guard's van testify that the winter sports season in Switzerland is beginning early this year ; most of my companions, however,

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judging from the labels on their hand-luggage, are bound for the more Capuan delights of Brussels, Paris or the Riviera. I see no other luggage labelled, like my own modest suit-case, "Bombay, *via* Paris, Constantinople, Aleppo, Damascus, Baghdad and Basra." A foggy morning generally means a smooth Channel crossing; to-day, fortunately, is no exception; the *Maid of Kent* glides quietly out of Dover Harbour, and two minutes later the white cliffs of England are but a memory.

At Calais, a comfortable reserved *coupé* is in readiness on the Simplon-Orient Express, which takes one direct to Constantinople in three days. Here, as elsewhere on this journey, customs formalities are dispensed with in the case of hand-luggage of "through" travellers. Our first halt is at the Gare de Lyons in Paris, where we spend two hours while the train is being shunted and remade. The monotony of the journey may conveniently be relieved by a stroll in the town and dinner at a restaurant.

Monday Morning.—One awakes to find that the clock has gone forward an hour to central European time, and the train leaving Brigue just before entering the Simplon tunnel. From the abstract time-table, which the International Sleeping Car Company kindly presents to all travellers on their cars, I gather that we crossed the Franco-Swiss Frontier at Vallorbe at 5 a.m. The *wagon-lit* attendant takes charge of one's passport and railway ticket for the whole journey, and produces them as required from time to time by the respective officials concerned; one is thus enabled to sleep undisturbed through any international frontiers which the train may cross during the night.

From the windows of the breakfast car, as we pass the vineyards and chestnut woods of Pallanza, Stresa and Baveno, one can watch the morning mists lifting over Lake Maggiore. One notes, too, the semi-tropical appearance of the trim little railway stations with their palm trees and dwarf bamboos. Speeding eastwards all day across the plains of Lombardy, oriental memories are awakened by the universal dun colour of the cattle, and by the bunches of bright yellow Indian corn cobs hanging out to dry in the sun in the open verandahs of the peasants' houses. Far away on the northern horizon are the snowy summits of the Rhaetian Alps.

Venice is reached about five in the afternoon, just as the wintry sun is sinking. One's first impression is of endless mud flats covered with acres of belching factories and a forest of electric poles and cables of the most hideous variety. Twenty minutes later, however, the train backs out again over the same causeway as that by which it arrived; dusk has now fallen, dulling the crude outline of man's industrial handiwork, and a myriad twinkling lights are now reflected star-like from the placid surface of the lagoon.

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Strangers to Venice may well arrange to break journey here for a day or two. My own programme allowed for a day's halt at the far less convenient town of Zagreb in Jugo-Slavia, which is reached at the unpleasant hour of 3.40 a.m. However, my good friend the British Consul is in readiness for me with his car at the station, and soon I am asleep in a comfortable bed, not to awake until ten in the morning.

Zagreb, now a provincial town in the kingdom of Jugo-Slavia, was formerly known, under the name of Agram, as the capital of the little kingdom of the Croats, which for many centuries was incorporated in the Austro-Hungarian Empire. The town boasts of many excellent buildings, and a picturesque note is struck by the gaily embroidered dresses of the peasant women, with their country produce, who throng the various markets. Jugo-Slavia possesses but few arts or manufactures; the country is almost entirely agricultural. As the train hurries along, mile after mile, across the rich, alluvial and almost treeless plains of the Save, with their endless panorama of wheat, potatoes and millet, one might easily imagine oneself in the Punjab; there are the same winding, unmetalled, unfenced country roads, the same villages and the same irrigation wells worked by the familiar water-lift with its tall pole, lever and counter-weight; here and there an occasional creaking "Persian wheel." Nor is the illusion dispelled by the general appearance of the villagers on this bright winter morning, with their sheepskin coats and round Astrakan hats, and the draught oxen yoked in pairs to the farm wagons. Crossing the muddy waters of the River Save by a steel girder bridge, we arrive soon after midday at Belgrade, where a halt of twenty minutes is scheduled. This town, the capital of the erstwhile kingdom of Serbia and the present kingdom of Jugo-Slavia, is situated in the angle formed by the junction of the River Save with the Danube; it lacks, however, the dignity and impressiveness of its western rival, Zagreb.

Beyond Belgrade, the line trends in a somewhat more southerly direction past Nish to the Bulgarian frontier, which is crossed at Tzarlbrod at 9 p.m.; and here the clock goes forward a second hour to Eastern European time. Meanwhile, the country has again become more accidented in character; and the railway, now reduced to a single line, winds in and out among gently sloping coppiced hillsides, harbouring numerous little hamlets of tiled and white-washed huts.

Thursday, 1st December.—The temperature must have fallen pretty low last night, as I awoke to find the outside of my window obscured by great icicles eighteen inches long, formed by some water which had spilled in the night from the overhead tank in the roof of the carriage. I noticed, too, that the couplings of the train were

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decorated in a similar manner through the condensing of the steam, which had been escaping from a leak in the steam-heating apparatus. Inside the train there was, however, no lack of warmth; and it was perhaps due to this cause that I awoke only at 9 a.m., just in time to find the train crossing the Maritza River by a big bridge. The fact that we were now in Turkish territory was presently confirmed when the bill for my *petit déjeuner* was presented to me printed in Arabic characters and reckoned in piastres.

All day the panorama from the carriage window consists of bare, dry, rolling, grassy prairie, unrelieved by a single tree from horizon to horizon. Here and there, on a piece of rising ground one may see a village of squalid mud huts capped by a trim, whitewashed mosque with its tall, circular minaret. A few bare-footed, unkempt children come to gaze silently at the train as it stops from time to time at the stations. Turkish cultivation appears to be conducted on primitive lines, the soil being loosened by a simple wooden plough drawn by a pair of oxen; afterwards, the seed is sown without any apparent attempt at harrowing or rolling, nor were there any signs of the use of manure. Once only one noted, with surprise, a Fordson tractor hard at work drawing a multiple plough, which left in its wake a series of straight, well-turned furrows.

For the last twenty miles before reaching Constantinople, the railway skirts the shore of the Bosphorus; and the view across the still waters, with the sun setting over the Sea of Marmora and gilding the marble cliffs of the Asiatic shore, is one of singular charm and beauty. Just as dusk is falling, the train draws up at Galata terminus, where taxis are waiting to take one across to the hotels at Pera, the residential quarter of the city on the eastern side of the Golden Horn.

Friday, 2nd December.—To-day, all banks, shops and offices are closed, but in a few weeks' time an order is to come into force by which, in future, Sunday will be observed instead of Friday as the weekly holiday throughout the Turkish dominions. Meantime, one could but note the declining hold of religious observance among the population of the city. In the great mosque of St. Sophia, as well as in several others which I visited during the hour of prayer, the worshippers could be counted on one's fingers, where, twenty years ago, there would, according to my guide, have been thousands. To some extent, no doubt, this decline is due to the fall in the population of the city from its pre-War figure of 1½ millions to about 750,000, as disclosed by the census of 1927. It is now a crime punishable with imprisonment for any Turkish man to wear a fez, or for any Turkish woman to veil her face in public. This piece of legislation is said to have been acclaimed more cordially by the ladies of the country than by the opposite sex; anyway, the result is that the

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streets of Constantinople do not to-day differ largely in appearance from those of any other large Western city.

Besides the great mosque of St. Sophia, one should on no account miss seeing the Museum of Antiquities and the Seraglio Palace and gardens, all of which are situated in the Turkish quarter of Galata. The whole of the palace of the old Sultans, with its numerous pavilions, is now open to the public on payment of a small fee for admission ; particularly striking is the unique and priceless collection of old china, comprising over 15,000 samples of the oldest known Chinese workmanship.

II.—Constantinople to Bombay.

The bi-weekly train to Aleppo starts on Tuesday and Saturday mornings from Haidar Pacha terminus, on the eastern shore of the Bosphorus. This quarter of the city is reached by means of a steam ferry which plies at frequent intervals to and from the Galata Bridge, at the mouth of the Golden Horn. While waiting for the train to start, one may see, close to the station and in front of the Medical College at Scutari, the cemetery of the British soldiers who died in the base hospital during the Crimean War. A tall obelisk in the middle of the cemetery commemorates the labours of Florence Nightingale.

International *wagon-lit* carriages, identical with those used in Europe, run on the Turkish railways in Asia Minor, but only the daily express train to Angora is equipped with a restaurant car; on the Aleppo line and elsewhere, the trains stop at intervals in order to enable passengers to get their meals. The stations do not invariably boast any form of buffet, and it is occasionally necessary to search the town for a restaurant, unless one provides oneself beforehand with sufficient food for the two-day journey to Aleppo. One notes, by the way, that the line is still officially styled the Anatolia-Baghdad Railway, although its present terminus is no farther than Aleppo.

Leaving Haidar Pacha at 9.30 a.m., the train skirts the north-east shore of the Bay of Ismid for the first fifty miles. The landscape is green and verdant, even in winter ; rich fields of wheat, millet and tobacco alternate with groves of fig, peach, apple and quince trees. After half-an-hour's halt for an indifferent lunch at Ismid station, we plunge inland through the highlands of Anatolia. These reach their maximum development in the neighbourhood of Mount Olympus, where just before dark we traverse a remarkable limestone gorge some fifteen miles in length ; bare, rocky limestone hills rise sheer for 1,000 feet on either hand, leaving scarcely room for the railway to zigzag to and fro across the little mountain stream, with

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which it competes for possession of the valley. Here and there drifts of snow peep out beneath the bank of cloud which hides the crest-line of the ranges.

At 8 p.m. we halt for dinner at Eski Shahr, the junction station for the Angora line. From here onwards, the railway traverses a barren, featureless plateau some 3,000 feet above sea-level; and though the train itself is well warmed, one is glad of one's greatcoat when getting out at the station. My fellow travellers are as follows:—A young Syrian merchant returning to Aleppo from a business visit to Salonika, a Persian rug merchant with headquarters in Paris, a Jewish company director from Constantinople, and an alert young Turkish lawyer bound for Adana; all speak excellent French, and we while away the hours by playing poker for small stakes. About eight o'clock on the evening of the second day after leaving Haidar Pacha, we reach the Taurus mountains; as the train whisks in and out of the twenty or more tunnels one can catch glimpses, by the light of the full moon, of the terrific chasm of white limestone through which the railway threads its way.

The Syrian frontier is crossed at six o'clock in the morning, and Aleppo is reached at 9.30, exactly 48 hours' journey from Constantinople. From Aleppo one may either proceed by the Syrian railway to Damascus, or one may go—as I did—by car to Beyrout. The latter journey takes about ten hours; the road is bad for most of the way, and very dusty. One passes through the towns of Hama and Homs before reaching the Mediterranean coast at Tripoli. Most of the Syrian roads are considered unsafe for single cars after dark; we were accordingly stopped by the police at Homs, and only allowed to continue our journey at six o'clock next morning.

Beyrout, the headquarters of the French administration in Syria, is the largest seaport in the eastern Mediterranean. It is also of interest as the spot where the British patron Saint, Saint George, is alleged to have slain the dragon, and the bay on which the town is built is still called St. George's Bay. Here, as elsewhere in the middle East, there are a number of Russian refugees who eke out a precarious livelihood by keeping grog shops and dancing halls. Malaria is prevalent in Beyrout, and mosquito nets are very necessary during the summer months.

The Nairn weekly motor convoy leaves Beyrout on Thursday mornings, and Damascus is reached in time for lunch. The road, which is in excellent condition, crosses the Lebanon range at a height of 8,000 feet above sea-level. From the summit one looks back, over the vineyards and town of Beyrout, to the blue Mediterranean beyond. To the south is the snowy summit of Mount Hermon. After a long winding descent, we cross a flat valley ten miles wide before climbing the lesser range of Anti-Lebanon. The approach to

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Damascus is through miles of orchards—fig, olive, vine, quince, pomegranate and orange—watered by the river Barada (the Biblical Adana) before the latter loses itself in the Syrian desert. Next morning, we are on the road by 7 a.m., and an hour later we are in the heart of the desert. Hour after hour we speed over the monotonous expanse of bare stony soil. At noon, we halt for an *al fresco* lunch; shortly afterwards the Iraq-Syrian frontier is crossed at a low range of hills known as Jebel Tent. Here the clock goes forward a third hour, and the "rule of the road" changes from the Continental to the British. In view of the large number of cars now using the desert route, the observance of the rule of the road is of more importance than might at first sight appear.

Soon after dark, we reach the fortified post of Rutba, the half-way house of the desert. An excellent dinner is soon ready, and bedrooms with clean sheets for those who are staying the night. Eight other cars arrive within the space of an hour or so. Some cars resume their journey after dinner and drive all through the night, reaching Baghdad the following morning. This, however, is very tiring for the drivers. Some drivers, therefore, prefer to take a few hours' rest and resume their journey at midnight; others a couple of hours before dawn. Two or three cars are supposed to travel together for the sake of security.

The cold of the desert nights is very intense during the winter months; ten or twelve degrees of frost is often registered at Rutba, and I noticed that the motor drivers were careful to empty the radiators of their cars before turning in for the night. The total distance across the desert from Damascus to Baghdad *via* Rutba, is 540 miles; this is covered at an average speed of 30 miles per hour, and speeds of 50 or 55 miles per hour are frequently maintained for long periods. Occasionally the monotony of the journey may be broken by the sight of an Arab camp, or by a chase after gazelle. The Iraq customs post is passed at Ramadi, sixty miles before reaching Baghdad; an hour later we cross the Euphrates by boat-bridge at Faluja. Finally, the Maude Bridge across the Tigris brings us at once into the heart of the ancient city itself.

At Baghdad I was for five days the guest of kind friends, whose courtesy enabled me to visit most of the places of interest in and around the town. What most strikes the stranger on first arrival is the total absence of any available supply of stone suitable for building and road-making purposes. Even such bricks as are locally manufactured are so soft as to be scarcely capable of supporting the weight of a structure two storeys in height. Architecturally, therefore, the city bears little outward evidence of its historic past; few of the existing buildings are more than three or four centuries old, and of the glories of Harun-ul-Rashid nothing remains save the reputed tomb of his favourite wife. A fine new roadway is being

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constructed of reinforced concrete, running from north to south through the city, but the side-alleys which open off this roadway are mostly too narrow and winding for any but foot traffic, and the projecting lattices of the upper storeys of the houses often almost meet above the middle of the lanes.

The Iraq railways are similar to the meter-gauge system of India, and the 360 miles from Baghdad to Basra are covered in about twenty hours by the mail train. A dining car is attached to the train, and anyone not possessing a bedding valise can hire from the station-master at Baghdad a kit-bag containing clean sheets, pillows, blankets and *razai*. These are handed back to the guard of the train at the end of the journey.

Leaving Baghdad by the 8.50 a.m. train, it is easy to break journey at Hillah and to spend the afternoon visiting the ruins of Babylon, as laid bare by the excavations of Dr. Koldeway and his staff of German assistants during the fifteen years prior to 1914. The five-mile journey between Hillah and the ruins may be made by hired car, and it is well worth while thus to visit the ancient palace of Nebuchadnezzar, and the supposed Banqueting Hall of Belshazzar, on whose wall the moving hand traced out the fatal message of doom: "*mene, mene tekel upharsin.*" A night in the train brings one to Ur Junction, where there is a rest house with electric light and an Indian *khansama*. The great red *ziggurat* and the mound which represents the ancient city of Ur show up against the western sky-line a mile-and-a-half from the station. Here also, by the courtesy of Dr. and Mrs. Leonard Woolley, I was able to break my journey for a day in order to watch the astounding series of excavations at present in progress, and to observe at first hand the houses, streets, graves, ornaments and literature of the civilized Sumerian nation, which lived here some 3,500 years before the Christian era. The train finally reaches the quayside at Basra at midday, and the B.I.S.N. Co's. weekly steamer leaves on Saturday at 4 p.m., reaching Bombay seven days later.

CONCLUSION.

The journey described above occupied four weeks all but a day. This period might, of course, be somewhat reduced by curtailing some of the various halts for sight-seeing, but this I would not recommend. My tickets for the whole journey from London to Bombay were booked through Messrs. Thos. Cook & Son, of Berkeley Street; and the fares, including sleeping car accommodation for the whole distance from Calais to Aleppo came to £74. To this must be added a further £20 on account of food and hotel expenses incurred during the journey, fees for passport visas, and cost of sending my

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heavy luggage round by sea as cargo, to meet me in Bombay. Thus, my total expenses were as nearly as possible equal to the cost of a first-class "A" passage by P. and O.

A few hints on matters of detail may be helpful to those contemplating a similar journey:

(1) Luggage should be strictly limited to such items as can be taken into the railway carriage with one, say a couple of light suit-cases. Bedding is unnecessary, ditto solar topee.

(2) If travelling at any time between November and March, bring plenty of warm underclothing and a good overcoat, as the cold is apt to be severe for the greater part of the journey. Between 15th December and the end of January, rain is liable to fall in the Syrian desert and Iraq, and this may disorganize the desert motor services.

(3) If expense is a matter of importance, it is possible to save several pounds by booking second-class instead of first-class on the sleeping car over the sections Trieste-Constantinople and Haidar Pacha-Aleppo. The second-class accommodation is identical in all respects with the first-class, and there is little object in paying the higher fare. On the section Calais-Trieste it is only possible to book first-class sleeping accommodation.

(4) As regards the desert motor service, the Nairn Transport Company charge £20 for a first-class and £13 for a second-class passage from Beyrout to Baghdad; this includes food and hotel accommodation on the journey. Local firms in Beyrout and Baghdad quote £6 to £8 for the same service, but they have no foreign or outside agents, and their passages can only be booked on the spot.

(5) In regard to money, British £1 and 10s. notes are accepted with alacrity everywhere in Europe and the Middle East; 10s. notes are often more convenient than those of the larger denomination. As an additional precaution against theft, money may also be carried in the form of travellers' cheques, which are cashable anywhere, as required.

(6) Passport visas are not required for France, Switzerland or Italy, but are necessary for Yugo-Slavia, Bulgaria, Turkey, Syria, Palestine (if visited) and Iraq. The French language is widely understood in Turkey and generally throughout the journey as far as Damascus.

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"SWORDS INTO PLOUGHSHARES."

Being an Account of a Job of Reclamation Work in a Tidal Estuary.

By LT.-COL. T. C. SKINNER, R.E. (retired)

FOLLOWING the War and worse-than-war demobilization, the writer decided in 1921 to take a " busman's holiday " on the Council of the ancient Borough of Pembroke, being returned for Pembroke Ward as ex-servicemen's candidate by a majority sufficient to place the issue beyond risk of a recount. It was the signal for a cleavage in the ranks of the City Fathers, and often in succeeding years did he find to his undoing that majorities within the Council bore no discoverable relationship to those outside.

The times were hard. If Dame Fortune had smiled upon the adjacent dockyard town in war, the fickle jade had forsaken it in peace, and reduction succeeded reduction with such alarming frequency that the problem of finding relief work immediately became acute. It soon, too, became evident that small schemes of improvement, road widenings and such-like, ate up a lot of money with but little to show for it, and in 1923 the call for some more serious undertaking had to be faced.

At the south side of the town existed a swampy valley or common, the local Tom Tiddler's ground, where gypsies contended with borough refuse carts for each inch of firm surface, and children escaping beyond parental beck enjoyed deep but transient satisfaction in the wallows of a turbid stream. Originally it had been a tidal estuary in which, tradition had it, King John once assembled a navy preparatory to a descent on the Irish Coast. Whether that particular outrage was ever perpetrated does not appear, and we need not now concern ourselves with its survival value as an " injustice." Suffice it to know that with a long nose King John signed his Magna Charta, and by the twentieth century the Pen Broke estuary had silted up till it could harbour no greater offence than a toy steamboat ; the real menace was local and bacterial, and had to do, largely, with abattoirs.

For many years back, for centuries indeed, progressive members of the Ward Committee had striven for improvement, but the paramount convenience of being able to find speedy deposit for any and every unwanted thing, invariably tipped the beam against reform ; and such modest proposals as were initiated from time to

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time quickly expired for lack of continuity, since for a councillor to touch the Commons was to dig at once the grave of his municipal popularity. One partial improvement did, however, survive in the shape of a pond that had been dug as a collecting basin for flood water, and, round this as nucleus, the writer set himself to frame a comprehensive scheme for reclamation of the entire area as a public park and recreation ground. Not one scheme, however, but nine such, drastically modified, were urged and advocated, before a reluctant council could be induced to back any one of them. It was "Throwing money into a slime pit"; "The Commons had always been flooded and never would be any different," etc., etc.; but, in the end, the progressives won through, eventually securing a loan of £3,360 wherewith to carry out a work that originally called for double that amount. Of this loan, repayable in 30 years, the Government undertook to contribute 75 per cent. of the interest and sinking fund for the first 15, thereby reducing the average burden on the rates throughout the entire period of the loan to about twopence-farthing on the pound.

A start was made on April 6th, 1925, and the park was opened to the public on the 31st July the following year. Expenditure on labour worked out at about £1,200, or the equivalent of a year's steady work for 17 men, in contrast with the brief periods of employment of a like number under earlier schemes. Of the men employed 75 per cent. had served overseas.

As actually carried out the scheme secured for the town a hockey ground and a football field (alternatively cricket pitches for boys), two children's playgrounds, equipped by public subscription with swings, see-saws, "ocean waves" (a species of merry-go-round), sand pits, drinking fountains, and park seats, while sites were levelled for a bowling green, a croquet lawn and five lawn tennis courts. It was hoped that these last three items, being remunerative, would have been added, but the Government grant being less favourable for such, a majority of the Ward Committee voted against, and their construction had to be postponed *sine die*.

The cost of the whole scheme exclusive of playground equipment, worked out as £3,620, implying an excess of £260 on the allotment. Of the excess, however, some £235 had been directly caused by a Ministry of Health alteration of design of the concrete walling *after* the estimate had been approved; from which it will be seen that the work was carried out as planned to within £25 of the estimate—sweet solace to the writer for the pain of keeping a bang-up-to-date record of every penny of commitment and outgoing from start to finish. He had well remembered Lord Kitchener's pardonable pride in having finished the Omdurman Campaign "within the budget," a feat surely unique in the annals of war, and highly to be commended to all R.E. officers in time of peace no less. This happy result could

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not have been achieved but for the loyal co-operation of the Council staff, the unfailing support of the best Town Clerk in the world, and the devotion of the works foreman, a mason by trade, whose price was beyond rubies. He had been a "quartermaster" in the Great War.

THE OLD REFLUX VALVE.
(*Compare with photograph of the New Valves*).

Engineering problems met with in the course of the work, though on a small scale, were extremely interesting. The ancient river bed, traversed in summer throughout the half-mile length under consideration by a small sluggish stream, and heavily flooded in seasons of rain, was crossed at the lower or western end by a road embankment known as Monkton Bridge, the embankment spanning a culvert through which the stream found outlet. The outer end of this culvert had at some time or other been stopped down by a bulkhead of brick in cement carrying a heavy cast-iron reflux valve of 24 inches clear diameter (see Sketch), the purpose of the valve being to exclude the tide at high water while allowing the stream to discharge freely between tides. From the first it was evident that this valve was largely, if not wholly, responsible for the mischief, in that it was of too small capacity to clear all the flood water in the short intervals available, the surplus water backing up inside with cumulative effect from tide to tide till it eventually found easement in overflowing the banks, flooding roads and ground floors of adjacent houses.

The first task, therefore, was to clear out this valve, bulkhead and all, and substitute two large, steel-faced, wooden valves of special design, to give, as nearly as might be, the full cross-sectional value of the culvert, for evacuation of flood water. Not a penny was forthcoming for experiment and it was "sink or swim" from the

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start, the new valves having to be designed, built, and provisionally fitted to the outer face of the culvert, before the old could be touched: one had to "put one's shirt on" the design; there was no second chance.

The bulkhead had been built to last, and it took more than a week of "tide work" to cut it out; but, when done, and the new valves had been shipped, the effect was immediate, the whole of the flood water being cleared in less than two hours from the first movement of the valves with the falling tide. Neap tides had, of course, been chosen for the change-over, to minimize the flooding while the bulkhead was being removed, but from that time forward there were no more floods save on one occasion when the bottom valve had been spragged open by a large piece of wood, by whom it was never discovered.

So far good, and the next thing was to design a strainer for the inner end of the culvert, to prevent the valves becoming clogged with debris. Some old fencing standards served for a rough trial to gain ideas, and a grid was then designed, 6 feet high by 12 feet wide, to allow by calculation ample waterway between the vertical bars, *plus* a good margin, with the culvert working full bore. This served well till the leaf came down in autumn when, so great was the glut that ten minutes would suffice to choke the upper half, and some modification had to be sought. The bottom panels were cut out and replaced by portcullises, capable of being raised or lowered at will, but allowing a permanently clear waterway of six inches at the bed of the stream. It was a tough job, involving accurate concrete work under water, but the result was satisfactory.

Next, after everything possible had been done to make the valves watertight on the masonry face, observation disclosed the disquieting fact that many of the springs infesting the upper areas were tidally affected, being at their maximum flow 24 hours after high spring tides; in other words, the tide that had been held up in front, had sneaked round the flank and got in after all. It was a question of quantity, however, and a long series of observations in all weathers and conditions of tide established the fact that the volume of water thus entering was negligible.

Simultaneously, it was found that a strong east wind, blowing outwards through the culvert, tended to hold the valves open to the incoming tide, while a wind from the opposite quarter operated to shut them against the outflowing stream; either effect being to measurably reduce the benefit of the valves. The first trouble was met by attaching counterweights outside to balance the wind pressure; the second proved, like the tidal springs, negligible in effect, the evacuating power of the valves being found ample for every contingency.

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Meanwhile the banks of stream and pond were being revetted everywhere with concrete walling, and the areas filled with some 20,000 loads of spoil, carted from Grove Quarry half-a-mile distant. All perennial springs located in the marshes were piped through to the stream, the intermittent ones being effectually sealed over as with a damp-proof course by the spoil from the quarry, locally known as "hog." Bridges were demolished and rebuilt where necessary, to remove obstructions from the waterway, and lock gates were provided for flooding and emptying the pond.

The areas were then enclosed with tubular railings, and the whole levelled and seeded down. It was feared at first that the seed would not take well in the "hog," which was, in effect, "poisoned" soil, but a little basic slag, added before sowing, made all the difference, and the result far exceeded expectation, the area being soon clothed with a good grazing turf which is standing up well against football, etc. Tree-planting is now the order of the day.

Nothing succeeds like success, and nothing could have been more remarkable than the change of public opinion as the work progressed. To have confined the muddy stream within concrete walls, alone made a great impression: this, at any rate, was something to show for the expenditure, while the park seats, that had been discreetly and quite unofficially put into commission immediately on arrival, worked overtime for months in the good cause of propitiating "oldest inhabitants" and weakening the hands of the "die-hards."

The opening day will long be remembered for its glorious sunshine, and the still more glorious "back slapping" of the formal ceremony, ere swings and see-saws were released by generous donors to joyous multitudes, to the strains of the 5th Welsh Band. At night, a fairyland illumination of the pond, and a *feu de joie* of fireworks, by way of farewell to King John, added finishing touches to a four years' campaign *à l'outrance*, from which the chief lesson the writer derived was that the proper study of mankind is man—not engineering.

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"SWORDS INTO PLOUGHSHARES."

PEMBROKE COMMONS IMPROVEMENT SCHEME.

The Pill (pool) below Monkton Bridge.
"Such quantities of mud."

The Valves that did the trick.
Half-tide—rising. Lower valve still working.
(N.B.—Arch on outer face is higher than arch of culvert. The dotted circle shows clear section of old valve for comparison,)

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Experimental Strainer of old fencing standards across inner end of culvert. 5 ft. × 4 ft.

Permanent Strainer, 12 ft. × 6 ft., going up in four sections outside the temporary one.

Making a beginning on the Stream.
Going down for Foundations.

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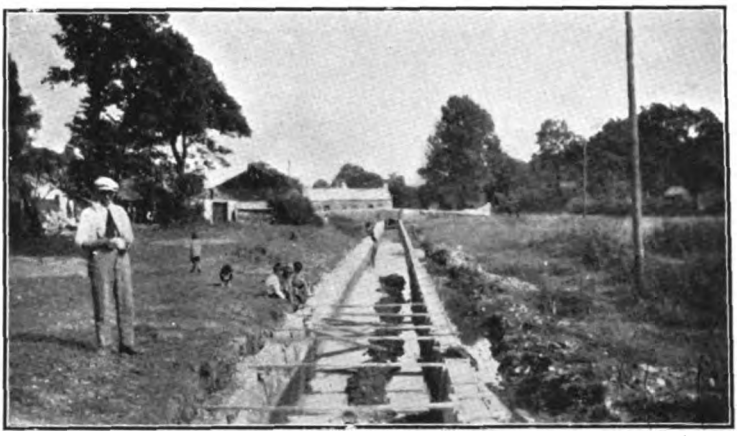

The Long Reach from Grove Bridge.

The Bend at Rock Terrace.—Fixing Shuttering.

New Way Bridge.—Reconstruction.

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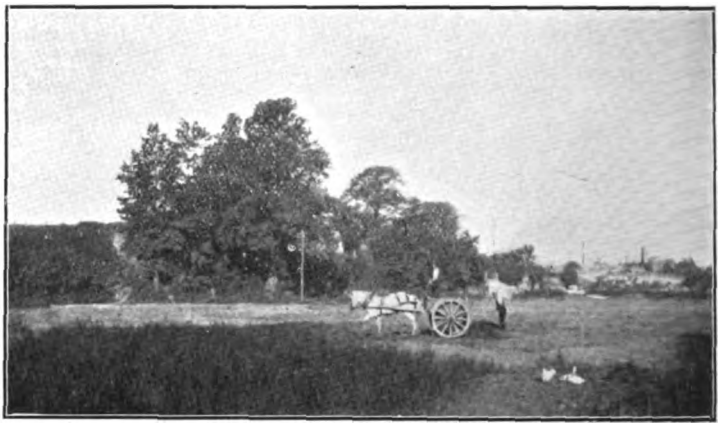

Filling the Bogs.—One load of 20,000.

Farmer Jones sowing grass seed where once King John's navy rode at anchor.

Back to sea again.
"A life on the ocean wave; a home on the rolling deep."

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REUTERS.

Lecture delivered at the School of Military Engineering, Chatham, on Thursday, October 25th, 1928, by SIR RODERICK JONES, K.B.E., *Chairman and Managing Director of Reuters.*

IN your programme the title of the present lecture is given as "Reuters." That title covers a very big subject, and at first sight it is a little difficult to know where just to begin. There is so much that can be said, while the time available for saying it naturally is limited. My difficulty is increased by the fact that you probably do not want to hear merely about Reuters. I imagine that, in addition to being told about the organization and working of one particular agency, you would like to hear something about the collection, the handling, and the dissemination, of that class of intelligence which is called news, as distinct from other classes, military intelligence for example, which often may be most desirable news but for official reasons is not publishable. Consequently, the field confronting me is a wide one, and I cannot hope to cover it either to your or to my own satisfaction. The most I can do is to touch upon it at what seem to me to be conspicuous points, and to leave you to catechize and interrogate me, if subsequently you wish to do so, upon whatever may be obscure. I will begin by telling you something about Reuters, its foundation, its growth, and the lines upon which it is conducted, and after that I shall deal with the general question of news collection and dissemination.

The Agency was started over eighty years ago by Paul Julius Reuter, a young German who came to this country and became a naturalized British subject. There was nothing strange in this. Those were the early days of the Victorian era and the Prince Consort, when the links, personal and other, between Germany and this country, from the Court downwards, were very strong, and when the enmities which more than half-a-century later led up to the Great War were not dreamed of. Julius Reuter was a man of imagination and genius, and he was the first man in this country, indeed, in the world, to envisage the great possibilities of wholesale news collection and its redistribution on a large scale. Reuter was a Jew, and it is interesting to note that the chief collectors and carriers of international news for centuries before belonged to the Semitic race, from the bearers of intelligence in ancient oriental bazaars down to the Fuggers in the time of the Holy Roman Empire, and from then on to the days of

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Waterloo, when the Rothschilds, according to the popular legend, scored heavily in their business by obtaining their own advance reports of the progress and outcome of the battle. But the purpose of all these purveyors of information primarily was, not to ensure its publication in the news sheets of the day, but to employ it in the advancement of their financial and trading operations. Indeed, this was Reuter's purpose also when he started. As an enterprising young Bank Clerk in Aix-la-Chapelle, he studied the activities of the various markets as shown in the reports—inevitably belated—which the slow old mail-coach brought from Brussels. As his interest in his hobby grew, it became evident to the young man how valuable the information contained in the reports would be if only he could obtain it before anyone else, and communicate it while it was still up-to-date to the big financiers of the town for use in their deals. He hit upon the idea of employing carrier pigeons to bring him the information speedily from Brussels. Buying a few birds, he arranged with a friend in the capital to release two of them immediately the Bourse closed each day, after having attached to each a little silken bag containing a thin slip of paper on which were written the latest market prices. The young man's scheme worked splendidly. The birds always reached Aix hours ahead of the mail-coach, and the financiers paid him handsomely for the invaluable information with which he was able to supply them. The bank clerk bought more pigeons to extend his business to other Continental centres, and he was quick to realize the possibilities of the first cable between Calais and Dover. He saw himself as a provider not alone of commercial and financial prices and rates for bankers and brokers, but also, through the newspapers, of interesting political and other intelligence for the general public.

Crossing to England, he made London the head office of his business, becoming a naturalized British subject. He began in a very small way of business in Royal Exchange Buildings in the City, and it was some time before he was able to convert the Newspaper Press of this country as a body to his ideas. Once he did, his success was assured, and from then onwards he never looked back. His Agency was conducted more or less as a family affair until 1865. In that year, he sold it to a concern styled Reuters Telegram Company, Limited, of which he had supreme control, and the original deed of sale is one of the most treasured documents in our archives at Reuters. The original capital was £200,000. In later days, it was increased to over half a million, fully paid up. In 1879, Baron Julius de Reuter, as he had now become, retired from the control of the Agency, and he was succeeded by his son, Baron Herbert de Reuter. Shortly after the outbreak of the Great War, Baron Herbert de Reuter died, and I succeeded him. One of my first duties was to reorganize the ownership of Reuters.

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As a Joint Stock Company with some 1,200 shareholders, it occupied a vulnerable position. Reuters shares could be freely bought and sold on the Stock Exchange. There was nothing to prevent them falling into hands that would not necessarily be friendly to the Allied cause. It was realized not only by the Board of Reuters, but also, and very seriously, in the highest official quarters as well as amongst the great body of the newspapers, that in a time of national crisis this would be nothing less than a calamity. Consequently I created a private Trust, to be maintained under my own unfettered control, consisting of four well-known public men and myself. We then bought out all the old shareholders, and we vested the ownership of the Agency in this Trust. Though primarily a war measure, the Trust proved so satisfactory as a means of entrenching and safeguarding the control of the Agency that I decided to perpetuate it. The upshot was that three years ago the Press Association of the United Kingdom, jointly with myself, became the Trustees in respect of Reuters for the newspapers of the United Kingdom and, either at my death or upon my retirement, the entire ownership of Reuters will pass, as in large measure it has already passed, into the hands of the British Press. This means that for all time, so far as is humanly possible, the control of Reuters as a national institution is absolutely assured, because, whatever political divisions there may be, and are, between sections of the Press, there can be no doubt of the attitude of the Press as a whole in days of national crisis.

I trouble you with this survey because, although Reuters is entirely an unofficial institution, and has always prided itself upon its absolute independence and its freedom from official as from other influences, it nevertheless does occupy a special position as the principal news agency of the British Empire and indeed as the principal international news agency in the world. This was particularly demonstrated during the War, when Reuters became the main, I might almost say the only, channel for the telegraphic presentation in every part of the globe of the British case from hour to hour and from day to day. The Agency's cable bill during that period ran into several millions. Heavy as it was, it represented only a small percentage of the vast sum spent by the Germans and their Allies in the telegraphic presentation of the enemy case. Thanks to the world-wide extent of the Reuter ramifications, literally from China to Peru, and to the Agency's having at its disposal machinery and channels far more abundant and more efficient than those available to anybody else, thanks also to another reason which I shall mention presently, the British telegraphic propaganda, notwithstanding its substantially lower cost, got the better of the German propaganda more than two years before the War ended.

The reason to which I have just alluded is this. The popular idea, and certainly the foreign idea, of propaganda is that it should be

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distinctly tendencious and, on occasion, deliberately misleading. The practical application of that idea in the German propaganda, which in other respects was conducted with ability as well as with energy and lavish expenditure, was largely responsible, first for its relative ineffectiveness, and then for its failure. The British telegraphic propaganda, on the other hand, was conducted on the principle of telling the truth, even when the truth might be unpalatable to ourselves. When I say this, I am speaking more especially of the telegraphic services that were compiled and dispatched by Reuters, which I should think represented 90% or more of the whole. The penetrating influence of these Services in foreign countries all over the world excited the envy and provoked the anger not only of the German authorities but also of the German people, and by the end of the War the name of Reuter was both hated and respected throughout Central Europe. During the third year of the War, a German submarine succeeded in cutting one of the British cables, the only one, thanks to the vigilance of the British Navy, that the Germans ever managed to tamper with. When the British repair ship subsequently picked up the ends of the cable to piece them together again, attached to one of them was found a bottle in which was a slip of paper bearing the words: "This is the work of U Number 4, and puts a stop to Reuters' damned anti-German work." It was in the same year that the famous German humorous weekly, *Kladderadatsch*, devoted its entire number, from cover to cover, both illustrations and letterpress, to a satirical and enraged attack upon Reuters.

From first to last, these special Reuter services were conducted in the interests of the State without any sort or kind of official dictation or official interference. The authorities in general, and the Foreign Office in particular, had the wisdom to recognize that Reuters' reputation for accuracy and impartiality was a thing that could be turned to very good account in all parts of the world. They perceived that where an official propaganda, however well disguised, would come under suspicion and be ineffectual, reports going forth from Reuters or under the Reuter name would be accepted and believed. Fortunately they also realized that this would hold good only so long as the Reuter telegraphic services to different parts of the Empire and to foreign lands continued fully to be trusted by the newspapers and by the public for whom they were designed. This process of reasoning led inevitably to the conclusion that the whole business of handling these vast news services should be left entirely in the hands of Reuters, who, as a British institution, must be trusted to do what was best for the Allied cause. It is the fashion from time to time to abuse Governments and Government Departments for their supposed poverty of imagination, no less than for their lack of business sense, and, above all, common sense. I am glad to be in a position to quote from my own personal experience a striking proof that this abuse is

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not always justified. In the Reuter case those concerned, Cabinet Ministers and officials alike, displayed imagination, common sense, and business acumen.

I have delivered a number of lectures and speeches on news questions during the last few years, but I have never before dealt so specifically with Reuters' functions and position during the War. I present the facts for the first time now to you because it seems to me that, as military men, presumably with wars ahead of you, they may have a special interest. And I would not have you think, when I speak of the freedom and discretion that were left to Reuters in the present case, that I am one of those who believe in freedom from a censorship in military matters. On the contrary, in my judgment, such a censorship not only is desirable but is absolutely indispensable, especially in or near a theatre of hostilities. The issues at stake in a campaign often are so serious, the consequences of information reaching the enemy, or even neutrals, can be so grave, that the military authorities are entitled, indeed they are under an obligation, to exercise the most strict supervision over whatever news goes forth, especially from the actual seat of war, of a direct and even of an indirect military character. This view is one to which, I believe, all responsible directors of news organizations, and all responsible correspondents, will subscribe. We who deal in news dislike censorships as such. They always are an inconvenience, they frequently are a nuisance, and more often than not they fail completely in their purpose. In certain parts of Europe, censorships are to-day being enforced which are tyrannical and grotesque in their working, and mischievous in their consequences. If attempted anywhere in the British Empire they would produce a riot. But there is all the difference between such censorships and the reasonable and intelligent control over news relating to military affairs to which, during a campaign, and especially during a time of national peril, the men who are fighting for their country, whether on land or at sea, and indeed the country itself, are entitled. You will observe that I use the words "reasonable and intelligent" in relation to the control exercised. Those qualifying adjectives are necessary. Where a censorship is exercised unreasonably and without intelligence, however justifiable in principle the censorship may be, it is bound to cause irritation and to excite the opposition of correspondents, the agencies, and the newspapers, and ultimately to defeat what should be one of the principal aims of a sagacious and prudent censorship, namely, to secure and to maintain the sympathetic and spontaneous co-operation of the Pressa nd itsr epresentatives. During the last War. that co-operation generally existed. There were exceptions, especially in distant and isolated areas, but, for the most part, after making due allowance for human fallibility, the censorships at various points worked smoothly and on the whole were rational.

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It would be hypocritical on my part to suggest that the keen and adventurous correspondent, eager to do his best for his agency or his newspaper, submits to a censorship without a pang. Military censorship in its modern and more methodical form has reduced greatly the scope and opportunities for the exercise of individual resource and enterprise. What in journalism we call "scoops" are less frequent, and certainly less dramatic than they were in former days. I daresay some of you know the story of Archibald Forbes, the celebrated war correspondent of the *Daily News*. He had just witnessed one of the opening battles of the Franco-Prussian War, I forget for the moment which. The nearest telegraph office was miles away. There was a single operator and a single line. Forbes had competitors. Whoever got his message on to the line first could hold the line until the message was finished. There was a wild race on horseback across country for the telegraph office. Forbes laboured under a disadvantage. One at least of his rivals had prepared a message. Forbes had not written a line. If this rival got his message into the operator's hands first Forbes was done. Forbes spurred on his horse and reached the telegraph office three or four lengths in front of the others. He had a pocket Bible. Seizing telegraph forms, he pinned on to them the opening pages of the Book of Genesis, and commanded the operator to signal them on to London. When the message began to arrive, the men at the *Daily News* office thought Forbes had gone out of his mind. But when, about the middle of the first chapter of Genesis, the biblical narrative passed abruptly into a vivid description of what had been a great battle, they realized what he had done, and the *Daily News* next morning scored a memorable success over all its contemporaries. A modern censorship would have made such a brilliant stroke impossible.

Some of you possibly may recall another story, one for which Reuters was responsible. At 9.15 in the evening of Friday, May 19th, 1900, Reuters published a message from South Africa announcing that Mafeking had been relieved. The Reuter telegram was read from the steps of the Mansion House by the Lord Mayor, and a copy also was sent at once to Queen Victoria and the Prime Minister. In a few minutes, special editions of the evening papers spread the news like wildfire, and almost instantaneously London was in the throes of a jubilant and boisterous demonstration which resulted in the coining of the word "mafficking." Time went by and no official confirmation of the Relief arrived. Towards midnight, Mr. Chamberlain was pressed in the House of Commons for information. He had to admit that he had none. But he added that he had every confidence in Reuters' accuracy. The process of mafficking went on through the night. Saturday dawned and wore on into afternoon, still without any confirmation, official or unofficial, being received. Lord Roberts, then in command in South Africa, was cabled to. Still no official confirm-

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ation. The authorities and the newspapers began to be uneasy. I will not disguise from you that those in charge of Reuters were uneasy too. They had every confidence in their man, a tried and trusted correspondent. But had there been some awful mistake?

On the Sunday morning, Lord Roberts had sufficient faith in the Agency to have the Reuter telegram, which had been cabled back to South Africa from London, read to the troops on church parade at Bloemfontein, where the Commander-in-Chief was then stationed. Eventually confirmation came. The explanation of the mystery was that Reuters had received the news from a correspondent of theirs who had managed to persuade the Boers to let him remain on their side. The Boers knew that Mafeking was relieved before the British did because the British relieving force was very far from its base, and for a time out of telegraphic touch. The Reuter correspondent rushed the news out through the neutral Portuguese territory, and got it on to the Eastern Telegraph Company's cable at Lourenço Marques a couple of days before anybody else. Meanwhile, it took the same two days for the British in Mafeking and the relieving column to get their reports through to the British side. Hence the anomaly of people in South Africa having first to learn from, and for two days to be solely dependent upon, a Reuter telegram from London for news of a momentous event that had happened in South Africa itself. The correspondent, I may say, was a Scotsman!

No news organization ever received a higher compliment than that for more than two days, without official confirmation, and without any corroboration from any other source, the whole of the British Empire should have celebrated the Relief of Mafeking entirely upon Reuters' word. Not less striking were the tributes repeatedly paid it during the Great War. A certain Reuter message was held up by the authorities, though the same message was published elsewhere. There were good reasons for withholding the news. But Reuters naturally asked why there should be this discrimination against them. The answer was, "Because if this news is published under Reuters' name people will believe it."

I think I can say with all modesty that this belief in the reliability of Reuter reports is almost universal. In the Far East, so high does the Agency's reputation stand for accuracy that the word "Reuter" is used by the Chinese in their own tongue as a synonym for truth. And, when I was in Peking three or four years ago, the then Prime Minister informed me that Reuters' foreign dispatches were so trusted in China that the historian whom he had appointed to compile the Official History of China for the closing years of the Manchu Dynasty and for the opening years of the Republic was relying primarily for his record of international affairs upon these dispatches, of which complete files had been kept in the State archives in Peking for three decades.

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Speaking of China reminds me of an incident that occurred shortly before I arrived there. For a whole day the Shanghai Cotton Exchanges, the most important in the Far East, suspended operations because, owing to a cable breakdown, Reuters' Cotton advices from abroad had not come to hand. The merchants for twenty-four hours refused to deal, in the absence of the standard by which they were accustomed to check their transactions. For nearly half-a-century all over the East and Far East, Reuters has been either the only service of news, or, as in recent years, the dominant and paramount service. The Reuter commodity, metal, financial and other prices are the standard by which business is done from one end of the East to the other, in Bombay, Calcutta, Karachi, Madras, Singapore, Batavia, Hongkong, Shanghai, Hankow, Tientsin, Osaka, Tokio, and in many another mart. To the Continent of Europe Reuters conduct the most complete and most trusted of all international news and commercial services circulating there. In addition to their continuous telegraphic and telephonic services they make over a hundred wireless broadcasts every day. The importance to this country of such an extensive dissemination, especially of financial and commercial intelligence, whether in Europe or in other parts of the world, is so obvious that it need not be dwelt upon. All over Europe, since the institution of the Reuter wireless service, business people are being fed with British reports for all kinds of commercial and financial business, where formerly they had New York, Paris, Hamburg, Berlin and other reports. The tendency consequently is for these people more and more to turn to the United Kingdom to conduct their transactions. Not wishing to weary you, I will quote only one illustration. Recently the Czechoslovak Press Bureau announced that, in consequence of Reuters' frequent and regular supply of quotations, the Czechoslovak textile industry was now dealing directly with the United Kingdom, instead of purchasing its cotton through Bremen.

You may now like me to give you some idea of how news is collected and distributed. From Julius de Reuter's small beginnings the news agency system has become a vastly important and an indispensable part of the mechanism of journalism as we know it to-day. Under that system, practically every square mile of the earth's surface is covered for news purposes at a minimum of cost. To illustrate what I mean, I will describe Reuters' part in that system. In each country in the world, without one exception, where news agencies exist the principal news agency, or the sole news agency in countries where there is only one, is affiliated to Reuters by long-term covenants. In France, for instance, we have the Havas Agency, in Germany the Wolff Agency, in Italy "Stefani," in Spain "Fabra," and so on throughout Europe; in the United States we have the Associated Press of America, and in other foreign countries a score more. In each of these countries, starting with all the countries of Europe and

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going right round the globe by way of India, the Dutch East Indies, China and Japan, the United States and South America, the whole Continent of Africa, from Egypt and Algeria to the Cape of Good Hope, the whole of Australasia and Canada, and the rest of the Empire, Reuters' agents and correspondents are established, and not only do they have at their disposal the news which they and their staffs assemble, but they also have the first and the exclusive call upon the news garnered by the affiliated agencies. That news, after having been sifted and examined by our own people, is passed by cable and by wireless to the Reuter headquarters in London, where it is sifted again and then is re-transmitted to every part of the globe, either under the Reuter name, as in Africa, North, South, East and West, in Australia, in New Zealand, in India, in Malaya, the Dutch East Indies, China, and in various other countries ; or else under the name of the affiliated organizations in their respective countries as part of their own services. Long practice and experience have shown that this process of assembling news at one great centre and then distributing it to the whole world is cheaper and swifter than any other. For instance, a regular service of news between India and America can be conducted at present more swiftly and more cheaply by way of London than direct between India and America. In the ordinary course, people suppose that the greater the distance between two points the correspondingly greater the time required to bridge that distance. That is true as a rule in all things except telegraphy. It takes much longer to travel from London to Melbourne than it does from London to Edinburgh. But the distance and time factors do not bear the same relation to each other when we come to telegraphy. A telegram may reach Melbourne or Wellington, N.Z., from London much more quickly than a telegram will reach Edinburgh or even Brixton, from London. When one gets this fixed in one's mind, one is less affected than one otherwise would be by considerations of distance when contemplating the transmission of news. The efficiency of the route, and the amount of traffic on the route, are elements far more important than the element of distance. By virtue of this Reuter system of pooling the news of the whole world in London, and of smaller agency combinations which have grown up beside it, London has become the principal news clearing house of the world, and a maximum of output has been secured with a minimum of expenditure. Yet the annual costs of the Reuter combination of agencies alone are estimated at over five millions sterling per annum, and this sum takes no account of what is spent by news agencies outside the Reuter alliance. I mention these figures merely to give you an idea of the extent and magnitude of the activities of only one section of the men who labour in the news fields of the world.

The responsibility resting upon these men increases year by year.

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By no means their least important task is to interpret the people of one country to the people of another. Upon their interpretation depends very largely the creation of good feeling or of ill. And not upon interpretation alone. In the mere selection and objective recording of events a correspondent can influence the mind of his readers. If from any particular country tales of nothing but drink and banditry go forth, while 90% of the news, mostly good, is ignored, the rest of the world cannot be blamed for coming to the conclusion that that country is largely peopled by thugs and vagabonds. I give an exaggerated example in order to illustrate the point I wish to make. It is that as much care and thought need to be devoted by correspondents to the mere selection and objective presentation of news as to its interpretation. And when we come to the handling of political and international news, these men more and more have the peace of the world in their keeping, a fact that has been emphasized repeatedly during the last few years in my own hearing, and often publicly, by Foreign Ministers, including our own, and by other public men, in almost every country that I have visited. In so far as correspondents portray the daily life and the activities of the people of one country faithfully to the people of other countries, they help to break down the barriers which divide the nations from each other, and they contribute to the creation of better international understanding and to the promotion of peace. In the newspaper of to-day news swamps and overshadows ideas. The journalism of ideas, the journalism of our grandparents, of our parents, and even of our youth, has given way to the journalism of information.

The night before I last left New York, I was the guest of honour at a private dinner at which a number of distinguished Americans were present. In supporting the toast Mr. Elihu Root, now a very old man and perhaps the most respected of all living Americans, delivered a striking speech, in which, drawing upon the wealth of his own long experience and shrewd observation, he enlarged upon this theme. Subsequently, in response to a desire I expressed for an epitome of Mr. Elihu Root's views in his own words, that gentleman wrote :

> " The substance of the idea which I tried to express was that, with the extraordinary growth of news service in recent years, the public in all civilized countries has been acquiring the habit of being informed from day to day about what is going on in the world, and this habit has greatly changed the basis of political action by the great self-governing democracies. For a long time I have been observing evidences of this effect in American political life. The American voters were formerly moved very largely by stump speeches and strongly partisan editorials, and by what they were told concerning public events in the course of whirlwind campaigns immediately before election. To-day, as a rule, new

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> elections are decided before the political campaign begins, and they are decided on the basis of the news which the voters have been reading from day to day ever since the last election. This means that the news gatherer and disseminator has passed into a position of greater consequence and power. His importance has increased and the importance of the editorial writer and the orator has decreased relatively, and it means also that the news gatherer and disseminator has greater responsibility for sincerity in the pursuit of truth, and accuracy and fidelity in its presentation."

I quote these words of Mr. Elihu Root because they are the words of an observer and a thinker and a statesman, and also because they epitomize a view which in my travels in different parts of the world during recent years I have found to be almost universal amongst serious public men. It amounts to this, that a correspondent's elemental function is to record the truth, no more and no less. And in so far as they are interpretative, correspondents must strive to be as dispassionate, where national and international affairs are concerned, as the Recording Angel. To this end it is important, as I have implied earlier on, that news be free from official control or official inspiration. When I say this I am not thinking of official *communiqués* and authoritative announcements, whether military or civil, which from time to time rightly are issued by Governments and Administrations the world over. So long as they go forth frankly and undisguised nobody mistakes them, and no reasonable exception can be taken to them. What I have in mind is the spurious matter which is put about the world, largely by wireless, and which, while masquerading as news, is simply propaganda (and here I use the word in its dubious sense, not in the sense understood at least by most of us on the British side during the War)—propaganda all the more dangerous because so often it bears an appearance of bluff honesty and engaging candour.

I must now close. I have not told you anything like the whole story. If I attempted to do so, I should weary you. I have given you a few facts and a few figures. I wish I had the power to invest them with the inexhaustible interest, the potentialities, and the fascination of my theme. The story of Reuters, to those of us of the third generation who have given a life-time to its service, is a romance and an epic, and if I appear to have spoken of the Agency in terms which, when I come judicially to examine them, I fear you possibly may regard as perhaps a little vain, perhaps a little boastful, I can only ask you to forgive me. I thank you very warmly indeed for the close attention and sympathy with which you have listened to me. You have made it a real pleasure for me to address you, and I only hope you will ask me any questions that suggest themselves to you. In answering them, as I gladly shall, I may come nearer telling you what you really want to know.

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R.E. FOOTBALL IN THE EARLY 'SEVENTIES.

By MAJ.-GEN. SIR RICHARD M. RUCK, K.B.E., C.B., C.M.G.

I HAVE been asked to write a brief description of R.E. football in the early 'seventies, which culminated in our team winning the Association Challenge Cup in 1875.

It is a long while ago, and memory may not be quite as good as one could desire, but with the help of a few other veterans, and an old record book, I have compiled the following notes in the hope that they may be of some interest to the Corps, as a sketch of a phase in its history which I suggest had some value in adding to the prestige of the R.E. as sportsmen.

The late 'sixties and early 'seventies were remarkable for a notable increase in the popularity of games: as a writer in 1872 said: "Athleticism is clearly in the ascendant. It would seem as if, while the wear and tear of brain augments, that, as a correction, muscular exertion is felt insensibly to be almost a necessity."

As regards the R.E. in the year 1869, Col. (afterwards Maj.-Gen. Sir Lionel) Galwey was appointed Commandant of the S.M.E., Chatham, and threw himself heart and soul into this movement. He was ably supported by some of his staff, more especially by Maj. (afterwards Col. Sir Francis) Marindin, who was his brigade major, and Captains Merriman and Fellows; the latter was, however, primarily a cricketer and that is another story which has been told elsewhere.

It may be called to mind that a sympathetic commandant and a sporting brigade major could at that time do much to retain at Chatham the services of a good cricketer or football player, by getting him posted to H.M.S. *Hood* for submarine mining duties.

Football, as played in the sixties' at the public schools, had almost as many codes of rules as there were schools; thus Eton, Harrow, Winchester, Westminster, and Rugby all had their own codes and customs, Rugby being specially distinguished by the prominent use of the hands as well as the feet; this variety made it practically impossible for many of the schools to play against each other and hindered the formation of old boys' clubs. Towards the end of the 'sixties, some of the old boys (to name a few, Alcock of the Old Westminsters; Kinnaird, Old Etonian; and Betts, Old Harrovian) founded the Football Association, to include all football clubs excepting those playing the Rugby or carrying game, and not long afterwards, a code of rules was evolved which was, I think, somewhat similar to that of Westminster School.

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The R.E. joined this Association in the year 1869, and the celebrated competition for the Challenge Cup was instituted in the years 1871–2.

At the commencement, the chief antagonists of the R.E. were the Wanderers (mainly an old boys' combination), the Universities of Oxford and Cambridge, the Old Etonians, the Old Harrovians, Gitanos, Crystal Palace, Clapham Rovers, and a few others. Football clubs were also formed in the north of England, playing a game somewhat similar to the Association code, the most prominent of these being Sheffield.

A notable difference between football of that period and present-day football was that in the 'seventies all players were amateurs.

All the R.E. matches from 1871 to 1875 were recorded in the old Club Book, which I have by my side; therein are descriptions of most of the games, together with extracts from various newspapers.

A summary of the matches played during these years gives the following results, the chief features being not only the few matches lost, but the extraordinarily few goals kicked against the R.E.

Year.	*Matches.*			*Goals.*	
	Won.	*Lost.*	*Drawn.*	*Gained.*	*Lost.*
1871–72 ..	16	1	4 ..	59	3
1872–73 ..	19	1	– ..	74	2
1873–74 ..	22	1	2 ..	70	8
1874–75 ..	17	–	3 ..	41	8

It is worthy of note that, during the first four years of the competition for the Association Challenge Cup, the R.E. were in the final match on three occasions, ultimately winning the Cup in 1875.

It is evident from a perusal of this old Record Book that the keynote of the R.E. successes was combination, not individuality, and that was the great advantage which the R.E. possessed over their opponents; the *esprit de corps* which was so marked in their professional capacity permeated their games; individually, as most of us knew, we were sometimes up against better players than ourselves, but, collectively, we felt equal to any club. In fact, Lord Kinnaird, than whom it would have been difficult to have found a better judge, was heard to remark that "the Sappers have discovered a new development of the game due to their greater combination."

Not that some of our players were not as good as the best. Von Donop was, in my opinion, in a class quite by himself as a wing forward, the "Prince of Dribblers," as one of the sporting papers called him. He was constantly being mentioned in the accounts of the matches either for brilliant runs on his own, or perhaps more frequently, for a combined movement with another wing player

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such as G. Barker, Blackburn, or C. K. Wood. I shall never forget the extraordinary manner in which he seemed to pivot round the opposing players one after another and then finish off by a most accurate shot to the centre.

Renny-Tailyour almost, if not quite, as good at football as he was at cricket, was frequently mentioned for his fine work as a centre forward, and possessed the happy knack of scoring goals when they were most wanted; he held the unique distinction of representing Scotland *v.* England in both Rugby and Association games. Rawson, an Old Westminster Boy, was a very expert dribbler and centre-forward, whilst Goodwyn and Onslow were exceptionally fine backs. Sim was another very useful back and was, I believe, the first player who made a practice of heading the ball, a method now brought to such a pitch of perfection.

There were others nearly equally capable, but the old volume usually prefers not to individualize, but to refer to the fine combined play of the wings, of the centres, or of the backs.

I must not omit to mention the two captains of the teams during this period, firstly Maj. Marindin, afterwards for many years President of the Football Association, and after him, Maj. Merriman, who captained the team which won the Cup in 1875. These officers were the making of the R.E. teams, thorough sportsmen in the best sense of the term, with the born capacity for leading. Merriman was also an uncommonly good goal-keeper, a fact not infrequently mentioned in the records of matches. Goodwyn also had much to do with the success of the early R.E. teams, for he was a most zealous and admirable secretary.

As regards the kind of game played at this period, the R.E. formation was a goal-keeper, one back, two half-backs, two players on each wing and three centres. The last were usually selected for their weight, strength and charging powers in addition to their talent as dribblers, the game being perhaps a bit strenuous, and many goals were got for the R.E.s by the combined forwards hustling the rival goal-keeper through his own goal all ends up, so to speak.

I notice a good few references in the earlier accounts of matches in the old book to very determined charging and hacking, methods which might perhaps be taken exception to nowadays.

The R.E. teams held their own well in this phase of the game, more particularly as a considerable proportion were old Rugby players. An amusing instance of what was called " fair hacking " is recorded in the old book, in an account of a match in 1873, when the R.E. were displeased with the unpunctuality of their opponents and the condition of their ground: it rans as follows: " Our fellows being by this time fairly well disgusted, began to peg into them pretty sharp, and ' little George ' (now Maj.-Gen. Sir George Barker, please forgive the impertinence) very soon sent a man to grass with a very

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sweet though fair hack, which was heard all over the ground; the individual was afterwards seen standing in goal on one leg like a stork."

But I must not emphasize unduly the rougher side of the game which was played; it was all taken in good part, and I doubt whether the really serious injuries were more frequent than at present.

I find the best general description of the game as played by the R.E. about this time in an extract from a Sheffield local paper referring to a match played during the Northern Tour of 1873: "A great feature of the play was the extraordinary energy and go possessed by the R.E. With the exception of the backs, the remainder were always on the ball, a course of proceeding which would greatly pump any ordinary team, but each and all appeared almost as fresh at the finish as at the commencement. Their defence of the Citadel was remarkable, and in one case of more than ordinary danger: the whole eleven were discovered in the mouth of the goal, much to the amusement of the spectators. The ball was no sooner out of danger than out went the skirmishers to return again if need be, and this zeal is most dangerous when played by a band of well-trained athletes like the Engineers."

The grounds, as well as the play, were sometimes rather rough in the early 'seventies, and allusion is made in the old record to "hayfields" and the inconvenience of having a large tree in the centre of the field of play; on one occasion the R.E. team was asked to assist in driving off the sheep, and in removing their "leavings" before starting the game.

Such being the general conditions under which we played football at that time, I propose now to refer briefly to some of the more important matches which were recorded in the old book.

I will begin with the Final Tie for the Association Challenge Cup in the year 1872, this being the first time the Cup was played for. The importance of the event is indicated in the following extract from *The Morning Post* of 16th March, 1872:

> "A great event in the football world will come off to-day at Kennington Oval. The Association Challenge Cup is to be contested for; the final tie is between the Wanderers and the Royal Engineers. The Wanderers comprise nearly all the football talent in the country, the great players who have represented the Universities and public schools are mostly to be found enrolled in this, the leading club of the Association. It will be seen, therefore, that the scientific soldiers will have a task before them that might well cause them to be doubtful of success. The habit of working together and understanding each other's play materially will help the Engineers. The leading club will doubtless show more exceptional brilliant form than the Engineers can be expected to do, but if we mistake not, there

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will be an amount of cohesion, co-operation and almost of discipline among the soldiers that will at all events go far to place them on a par with their, so to speak, more loosely organized but highly-skilled rivals."

The result of the match was that the Wanderers won by two goals to *nil*, and they were undoubtedly the better side, much of their superiority being due to their backs, Lubbock and Thompson; the game was described as the fastest and hardest of the competition, and Merriman was specially praised for his goal-keeping. One rather unusual incident occurred, for Creswell, one of the R.E. team, broke his collar-bone ten minutes from the start, and very pluckily played on to the end of the match. It is interesting to note that the task of the linesmen and referee was described as a sinecure. This was largely due, no doubt, to the good feeling amongst the players. For instance, it was considered the correct thing that, when the ball touched a player's hand or arm, and "hand" was challenged, he at once threw up his hand and acknowledged it without waiting for the umpire's whistle.

The names of the R.E. team who played in this match were as follows:—

Major Marindin, Capt. Merriman, Lieuts. Addison, Mitchell, Creswell, Renny-Tailyour, Rich, Goodwyn, Muirhead, Cotter and Bogle.

During the next season, there were a good many changes in the R.E. team, and Von Donop, Wood, Blackburn and I became regular playing members. The redoubtable Wanderers were played twice and defeated comparatively easily, but we received a check at the hands, or rather feet, of Oxford University in the Third Ties for the Challenge Cup. I notice that the old book declares that this defeat was due to bad luck, and that we were the best team of the year, but the fact remains that we were beaten by one goal (admittedly a lucky one) to *nil* after a very hard match in which Renny-Tailyour, Von Donop, G. Barker and Muirhead appear to have specially distinguished themselves.

One of the best matches of that year was against the Gitanos, a strong club and public school combination whose captain (Farmer) had vowed a "terrible oath" that he would bring a team to Chatham which would defeat us on our own ground. He certainly got together a very strong team, but they had to return to London defeated by one goal to *nil*, after a very exciting struggle in which there was some fine play by the players of both sides. For the R.E. the combined play of G. Barker and Von Donop is described as follows:

"No football team in the world possesses two men who play together or more thoroughly for their side than do these two."

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Addison is mentioned as playing beautifully at back, and Leach, who got the only goal, is also commended. I got a pat on the back for what was called a " miraculous " save when the ball was within a few inches of our goal line.

The chief feature of the 1873–4 football session was perhaps the Northern tour of the R.E., which was undertaken at the invitation of the Northern Clubs, the most important of which was Sheffield. This Club, which possessed an unbeaten record in the North of England, wished to measure its strength against the best of the Southern Clubs, the arrangement being that the game was to be played half-time under each set of rules, the chief difference in the Sheffield rules being the absence of off-side. Matches were also arranged with South Derbyshire and Nottingham under the usual Association code, the whole tour to be completed in four days (including Sunday) : pretty strenuous work. These matches resulted in a victory for the R.E. in each case—four goals to one against Sheffield, and two goals to one against both South Derbyshire and Nottingham, the R.E. suffering somewhat from staleness and injuries in the last two matches. Very large crowds assembled to see these matches, and the R.E. were most hospitably entertained, not only by their football adversaries, but also by a highly distinguished officer of the R.E., Sir William Abney, F.R.S., who had a house in Derbyshire, where he put up a large proportion of the R.E. team. I have already given a description of the nature of the games played by the R.E. during this tour, extracted from the Sheffield local press, who gave special praise to Von Donop, Wood, Rawson, Renny-Tailyour, Goodwyn and Olivier, but I expected that the merit might have been divided pretty equally amongst the whole team, whose names were :

Maj. Marindin, Capt. Merriman, Lieuts. Goodwyn, Von Donop, Olivier, Blackburn, Wood, Digby, Rawson, Sim, and Ellis.

A very hearty appreciation from the Sheffield executive closes the account of this tour, which was, no doubt, very useful in furthering the interests of the Association game in the North. The R.E. enjoyed their outing, but vowed that never again would they attempt to play three matches in four days.

At the beginning of the year 1874, the names of Stafford, Onslow, Wingfield-Stratford, and Mein appear in the list of R.E. players ; and Goodwyn has left, much to the regret of everyone.

The R.E., having won three of the preliminary ties for the Cup, played Oxford University in the Final on March 14th, but after a close match they were defeated by two goals to none ; it was described in the sporting press as a magnificent contest and closer than the score indicated. Oxford had a fine side, including Ottaway, Birley, Rawson and Vidal, and a word of extra praise is given to

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Renny-Tailyour, Digby and Von Donop of the R.E., for their play in this match. The names of the R.E. team were as follows :

Maj. Marindin (captain), Capt. Merriman, Lieuts. Addison, Onslow, Renny-Tailyour, Olivier, Rawson, Von Donop, Blackburn, Wood, and Digby.

The season of 1874–5 was memorable in consequence of the R.E. at length reaching the summit of their ambition by winning the Cup. Unfortunately, Maj. Marindin, who was Captain for so many years, and in the words of the old Record Book, " to whom was due in the main our success in former seasons," left Chatham before the season commenced. Addison, a very sound back, and Olivier, a very useful centre-forward, had also gone—on the other hand, Onslow, Stafford, Wingfield-Stratford and Mein had greatly improved their game, so there was the makings of a strong side. Early in the season, the R.E. played against a very efficient team representing the Wanderers, at the Oval, and defeated them by two goals to none, Rawson kicking both goals, his second goal being described as " one of the prettiest bits of play that has ever been witnessed at the Oval." Sim is also mentioned for his back play, and Stafford kept the R.E. goal intact against a formidable attack. Other strenuous games were won against the Gitanos, Cambridge University, Clapham Rovers and also Sheffield, before the R.E. engaged in the final struggle for the Cup. The Sheffield match was a harder one than that of the previous tour, for the R.E.s only just won by two goals to one. The local press was again enthusiastic as to the merits of the R.E.'s representatives. " A better balanced team it would be difficult to conceive. The forwards are mostly slim, tough, and wiry young fellows, whilst the backs are strong, stalwart, robust men, who can propel the ball whizzing through the air like a shot from a cannon. The goal-keeper, too, is cool as Charles Matthews in the play. The game was undoubtedly the finest yet seen on Bramall Lane."

Two individual members are specially alluded to, " that superb player, Von Donop, irrepressible, and almost ubiquitous, and Wingfield-Stratford, a counterpart of Von Donop, except a little lighter."

The names of the team who played against Sheffield in this match, were as follows (twelve a side) :

Maj. Merriman, Lieuts. Macgregor, Rawson, Ellis, J. C. Barker, Philpotts, Von Donop, Wingfield-Stratford, Onslow, G. T. Jones, Sim, and Blackburn.

The final struggle for the Cup was really a double contest against, first, Oxford University, and second, the Old Etonians, four games being played, as two of them were drawn.

These matches were not reported in any great length in the old Record Book. We looked upon the University as our most for-

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midable competitor that year and as the accounts showed, it was anybody's game. A little luck would have turned the scale either way; perhaps we had it, but, as reported, the R.E. team combined together in their very best manner and just managed to pull through; the last match against Oxford, after a tie, was described by the press as one of the finest ever played in the competition for the Cup, the R.E. winning by one goal to *nil*.

The first match against the Old Etonians was spoilt by a very high wind in which we were placed at a curious disadvantage, as we had to play one hour and forty minutes against a strong wind, and only twenty minutes with it in our favour, but such is the luck of the game, and we managed to make it a draw of one goal each; in the replay we did much better, as we scored two goals to *nil* and thus won the Cup.

The accounts of these matches show that we were up against the pick of the English Association players, and that it was to our better combination and physical condition our victory was chiefly due, although, no doubt, there were individual efforts which were most praiseworthy, but where all did so well, it would be invidious to particularize, and I am sure that the team, could they have been asked that this should be attempted, would not have desired it. The names of the players who played in the Final, together with their places in the field of play, were as follows:

> Maj. Merriman (goal), Lieuts. Sim (back), Onslow and Ruck (half-backs), Renny-Tailyour, Rawson, and Stafford (centres), Von Donop and Wood (right wing), Wingfield-Stratford, and Mein (left wing).

It is related that when the news of our Cup victory reached Chatham, the Commandant, Gen. Galwey (who was unavoidably prevented from witnessing the match) being on the parade ground at the time, regardless of all rules and regulations, threw his cap into the air. I wish that I could attach a sketch of this incident to serve as a tail-piece to these notes. It would, I think, convey to my readers a much more vivid idea of the enthusiastic spirit which actuated all concerned in R.E. football of that period than anything I have been able to write.

In conclusion, I may perhaps be permitted to remark that I look back on my association with these R.E. football teams as one of the greatest pleasures of my life; we were a veritable band of brothers, and I have no doubt, judging by what one hears of the Corps as it now is, the same spirit still prevails and combined effort is still the watchword both in work and play.

[*It had been intended to publish a photograph of the team that won "The Cup," but, unfortunately, it was too faded for reproduction.*—EDITOR, *R.E.J.*]

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IN CLOUDS ON THE MISCHABEL.

By CAPT. E. A. L. GUETERBOCK, R.E.

LAST year the weather drove Rex Miers and me off the Mischabel before we could do the Südlenzspitze or the magnificent mile-and-a-half traverse of the Nadelgrat with its four peaks—Dürrenhorn, Hohberghorn, Stecknadelhorn and Nadelhorn, each over 4,000 metres high. Towards the end of our leave last August, we found ourselves once more at Saas Fee, and it seemed only natural that as soon as we met our guide, Ignaz Zurbriggen, he should suggest without any prompting that we should go up to the Mischabel Hut next day. With an enterprising leader like Ignaz, we had every hope of success; so Rex and I set off next morning up the hot steep path to the hut with light hearts and heavy rucksacks.

The path had been well marked this spring and we did not have to indulge in the rock-climbing we did last year on our way up. Ignaz arrived later in the evening, having walked up in exactly half our time! The weather that evening looked as good as we could wish—a few clouds on the tops of the hills, but a perfect sunset. An evening in an Alpine hut is one of the joys of a Swiss holiday. The chief event is supper, at which the *pièce de résistance* is a wonderful soup, largely supplied by Mr. Maggi and containing everything from meat to cheese. We sat outside afterwards, smoking contentedly, watching the red glow creep up the hills across the Saasthal, listening to Philemon Zurbriggen's mouth organ, and longing for some beer from the "bergschrund" at Saas, 5,000 feet below us. (Definition, *bergschrund*: an outsize in crevasses forming a huge crack right across an ice slope; a place which is very difficult to pass and in which you may be delayed a long time before you can get out.)

Half-past eight, and bed-time for those who have a strenuous day in front of them. The inevitable *huttenbummelers* came up to bed late, woke everyone up, tried (unsuccessfully) to shut the window without our noticing it, and finally settled down and snored.

Ignaz woke us at three; after the usual mournful hut *chhoti haziri*, we set off by candle-light up the path leading up the ridge above the hut, wondering what on earth made us take up this idiotic form of sport. Dawn came and cheered us up; but the Mischabel were in clouds and the weather did not look very promising. We soon passed the well-worn tracks leading over the Hohbalen glacier to

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the Ulrichshorn and Nadelhorn, and our climb really began. Easy rock continued for an hour or so, and then we approached the big gendarme—a pinnacle which guards the ridge most impressively. He is a famous fellow, is this gendarme, and deservedly so, for a thin covering of ice on him may stop the climb altogether. One face falls, vertically at first, some 6,000 feet to the Fee glacier; the other is steep rock, perched on a sheet of ice or snow tilted up at an appalling angle. The book is rather terrifying about this bit of the climb and tells of a "*vire très étroite*" from which there is a "*vue plongeante sur le glacier*," of "*prises rares et minuscules*" and other horrors. But the rock was firm and not too cold, and the finger-holds were free from ice, so that it was not an unduly severe struggle that took us up the gendarme and down the other side.

Good sound rock led us shortly to an *abseil*, where one has to rope down a few feet of vertical rock wall. With its natural malignity, the rope stuck after the last man had come down, and was so persistent that we thought somebody must be holding it at the top, and wrongly accused a Swiss solitary climber who was following us. There are so many of these Swiss *alleingangers* that one wonders why they don't meet and climb together, instead of attaching themselves unwanted to other parties or falling off into a mountain grave.

We reached the top of the Südlenzspitze at 8 a.m., four hours after starting from the hut. For the last couple of hours we had been in a cloud, and so we did not delay over breakfast on the summit, but set off quickly once more into the mist towards the Nadelhorn. Owing to lack of snow last winter, there were none of those dangerous snow cornices which often infest this ridge, and we moved quickly along the *arête*, sometimes on snow and sometimes on easy rock. Gradually the rocks became more prominent and the last hour before reaching the Nadelhorn provided some magnificent ridge climbing.

The only decent comfortable spot at the top of the Nadelhorn is occupied by a survey beacon, so we had to go below the summit to find a place where there was a reasonable chance of not seeing a rucksack or ice-axe bound away into the abyss, while we were trying to balance elusive sardines on bits of bread. This throws a side-light on the real reason why climber's breeches are extensively patched at the knees, which is not that they are worn out there, but merely in order to cover up sardine oil stains!

The way down the Nadelhorn is easy. At first it was rather like walking on masses of slates, set on edge lengthways on the ridge. This gradually gave way to ordinary rubble and snow. We were down at the hut again by 12 15, very thirsty and nearly as hungry. Water is scarce at this hut, as it has to be carried over a couple of

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hundred yards of steep mountain side, often in the form of snow or ice to be melted in the hut. Hence, washing is not encouraged, though there is, I am glad to say, no limit to what one may drink.

During the afternoon, the clouds came down lower and the barometer in the hut went up. Before all the parties for the next day's climbs had come in, it began to rain. However, it's an ill wind that blows nobody any good, and, as soon as he heard the rain, the guardian of the hut seized a bucket and a bit of iron piping and proceeded to collect the rain-water from the roof. The first bucketful was pitch black, but it all went into store just the same.

The atmosphere in the " dining-room " of the hut that evening was absolutely solid. The stove was burning merrily, cooking food and drying clothes ; serried masses of humanity were eating and smoking. Rex, Ignaz and I sat on the door-step ; this did not cause as much obstruction as might have been expected as none of the other occupants of the hut showed any desire for fresh air. Early to bed again, and the usual struggle over the window. This time a German, who came in last, when everyone else was in bed, approached the sacred window in a suspicious manner, came in for a shower of abuse from Rex and me and, in spite of that, shut it. I think our language must have shaken him, for he failed to latch the window, and, to our great joy, the wind gradually blew it open again.

During the night the weather got worse. Ignaz came in at six, and I quite expected him to tell us that the weather was too bad to climb, but, instead of that, he merely said : " Good morning—well, shall we go ? "—no need to say where. It had been too stormy during the night to start at three as we had intended ; actually we got away at seven, four hours late, with the snow already getting soft and slippery, and a long climb ahead of us. Ignaz expected to be back at the hut at 7 p.m. and warned us that we should have to hurry. I had already once been dragged across a mountain at a great pace by Ignaz in bad weather, and knew what it meant on a small climb at any rate.

It seemed queer starting in broad daylight ; but the clouds were thinning and the sun shone through every now and then, and we all felt fit for anything. At 8 a.m. we were at the Windjoch, a well-named *col* or saddle between the Nadelhorn and the Ulrichshorn. Ignaz poked his head gingerly over the rocks to see how strong a gale was blowing over that desolate pass, but there was hardly a breeze that morning. Up on to the *col* we went and, to avoid the steep ice on the other side, we turned right and walked up the snow ridge of the Ulrichshorn, the further slopes of which are much less steep than the Windjoch. But even the amiable Ulrichshorn can show its teeth ; and its far side gave us a taste of what we missed on the Windjoch. Snow soon gave place to ice. Ignaz had *crampons* (a form of steel sandal with big spikes underneath), and the

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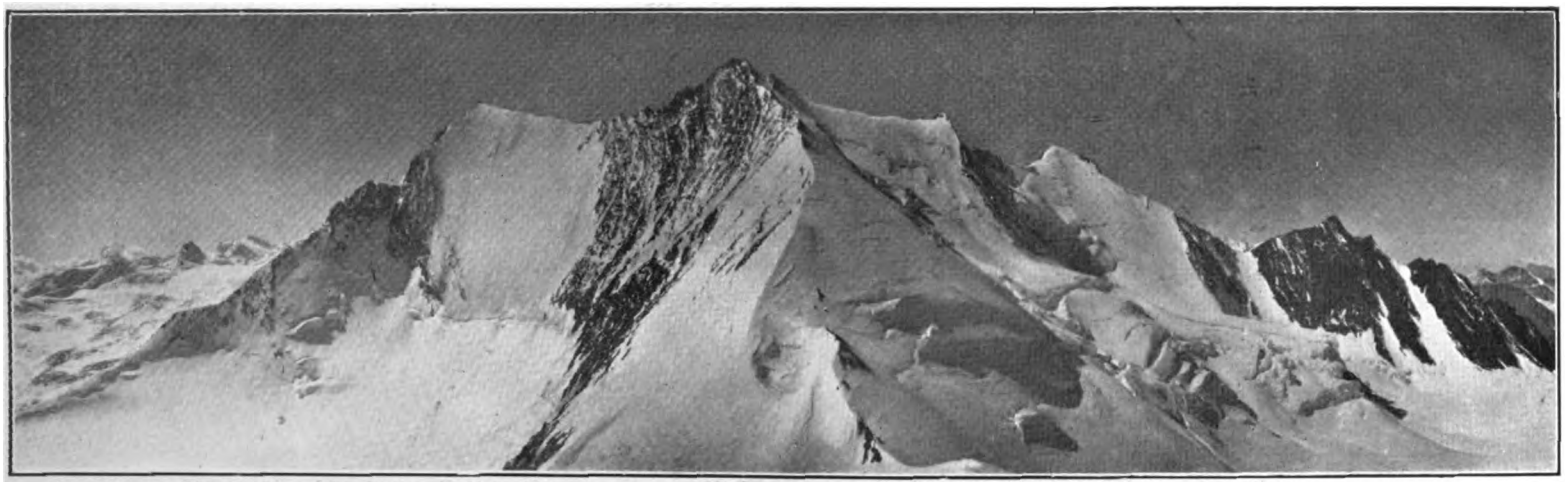
IN CLOUDS ON THE MISCHABEL.



Strahlhorn. *Rimpfischhn.* *Mte. Rosa.* *Südlenzspitze.* *Nadelhorn.* *Stecknadelhorn.* *Hohberghorn.* *Dürrenhorn.*

Hohbahlen Glacier. ***Ried Glacier.***

THE MISCHABEL GROUP FROM THE NORTH.

Taken from the Ulrichshorn.

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Nadelhorn and Südlenzspitze from Stecknadelhorn.

Südlenzspitze, showing the great gendarme on the left.

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ice was soft enough for these to bite into it, but Rex and I did not possess them, and we got more and more uncomfortable on that glassy slope, on which even our well-nailed boots felt like skates. "No time to cut steps," shouted Ignaz from behind, "go straight down; I'll hold you." So I led straight down and the inevitable happened. My feet shot from under me; the point of my ice-axe hardly made any impression as a brake, and I dragged Rex off his insecure foothold on the ice and went to the full extent of the rope. Ignaz saw it coming, dug his *crampons* in, and was as good as his word and held us. A tiring and slippery progress took us down at last, and across a *bergschrund* to a big snow-covered crevasse at the bottom of the slope. Ignaz shouted to me to glissade over this, there being some safety in speed on the principle of the mat bridge. The snow was, however, too sticky to glissade, but I sprawled across; Rex dropped one leg through, but the other foot was luckily on firm ice and he heaved himself out without checking a moment. Away we went at speed across the Ried glacier, towards the foot of the ice slope leading up to the *col* between the Dürrenhorn and the Hohberghorn. This year the foot of this *col* was guarded by a formidable *bergschrund*, a good hundred feet deep and presenting about 10 feet of vertical ice wall on the far side of a snow bridge. Ignaz wielded his axe with all his might and every blow was a shrewd one, but it took him twenty minutes to cut steps over this obstacle, and this provided a welcome rest for Rex and me.

A couple dozen more ice steps took us to the rocks of the Dürrenhorn, and nasty loose stuff they were. We climbed up quickly but carefully in order to avoid sending down stones on to climbers below, for we were followed by another party of a guide and two Germans. One of these was the gentleman who liked the window shut, so relations between the parties were somewhat strained! We got to the *col* at 11.30 a.m., dumped our rucksacks and ice-axes and set off along the narrow rock ridge to the Dürrenhorn. When Ignaz traverses a ridge, he does so religiously and takes everything humanly possible direct, and the last three little gendarmes provided a pleasant scramble. The other party took the easy path just below the crest, by which, having satisfied honour on the way up, we returned to the *col* for a short halt and food.

We were now well embarked on our ridge climb and, seeing us so committed, an icy wind came up with a snow storm and all view was gone for the rest of the day. It is a long pull up to the Hohberghorn, rocks most of the way, but at one point we had to climb up and across the top of an ice *couloir* which fell away like a funnel on the south side of the *arête*. The wind blew the snow up this *couloir* furiously and numbed our extremities, while Ignaz was hacking away with his ice-axe. We got to the top of the Hohberghorn at 1.30 p.m. —an hour-and-a-half after leaving the Dürrenhorn, and set off

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immediately down the other side, which was easy snow and provided a welcome relief.

The whole of this ridge is a knife-edge, its northern flank being steep ice, and its southern flank a precipice of broken rock. Unfortunately, we had no view, and the pace at which we went effectively prevented us from realizing how sensational the climb might be. We were all three moving together practically the whole time. The elaborate precautions, belays, etc., taken in the Lakes and Wales, would have delayed us impossibly long. It was an occasion for that mutual confidence and team work, which is one of the greatest pleasures of mountaineering. The management of the rope is an intricate, continuous and complicated business for the middle man, especially at such a pace, and Rex worked wonders that day.

The Stecknadelhorn was passed almost without our noticing it, for the storm was at its fiercest, and we scrambled breathlessly on with only a couple of minutes' halt, reaching the Nadelhorn at 3.30 p.m., one-and-a-half hours before schedule time. Here we had a very welcome quarter-of-an-hour's rest and then set off down the same *arête* we had descended the day before. But new snow up to three feet in depth had entirely transformed it, and the way down was by no means so clear. On the snow at the bottom the mist was very thick, and ridge and precipice, snow and fog were almost indistinguishable. We staggered wearily into the hut at 5.15 p.m. to find that, except for the guide and the two Germans who followed us, we were the only party who had been out at all that day. Several cups of hot tea and the remains of our provisions revived us considerably, and we set off again in the sleet and rain at six and quietly dropped down our 5,000 feet to Saas Fee, where a kindly head waiter provided two tired, dirty and unshaven men with a very excellent dinner in defiance of all rules about late arrivals.

Next day, to spite us, the sun shone gloriously on the Mischabel; still, the northern ridges of the group had been defeated. But then, I know only one thing which will make Ignaz turn back on a mountain and that is a thunderstorm, and the Mischabel had not used that weapon.

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NAVY, ARMY AND AIR FORCE INSTITUTES, GIBRALTAR.

By MAJOR H. E. COAD, S.R.E.S.

THE foundation-stone for the new premises of the N.A.A.F.I., Gibraltar, was laid in July, 1926, by His Excellency General Sir Charles C. Monro, Bt., G.C.B., G.C.S.I., G.C.M.G., the Governor, and the building was finished a year later. The design is of two storeys, and Spanish bricks 12 ins. x 6 ins. x 1½ ins. are used for the 12 in. thick walls which have piers 2 ft. square at 10 ft. centres, carrying the rolled steel joists of the upper floor and the steel roof trusses above. The exterior is cement rendered with ornamental string courses and lines, the piers showing on the outside as columns. The roof is of rough boarding covered with two-ply felt and grey asbestos slates.

The accommodation provided consists, on the ground floor, of a large bakery, refrigerating plant, engine room, refrigerating chambers, mineral water factory, grocery issue store and a store for naval groceries. On the upper floor are the flour store, furniture department, general store room, and offices for the Staff. Communication between the two floors is by a marble staircase at the main entrance, an electric lift, a wood staircase with sack chute in the issue store and an exterior cast-iron spiral staircase.

The first floor is constructed of concrete, reinforced with expanded metal, carried on rolled steel joists. Beams and columns are encased in expanded metal and plaster. The ground floor is of concrete. For the main part the building may be termed fireproof; the only fire appliances provided are buckets and Minimax Extinguishers, but fire hydrants are available in the vicinity.

The cost of the building worked out at approximately 10½d. per foot-cube. This price includes drainage and ejector plant, boundary wall, refrigerator chambers, but not refrigerating plant, mineral water machinery or bakery plant. A great deal of tiling both on walls and floors is included in the price, which is considered a very reasonable one.

The especial points of interest in the building are the foundation work, the drainage, the bakery, the refrigerator plant, and the mineral water factory.

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Foundations.—The site of the building is land reclaimed about thirty years ago from the sea. It lies about 40 yards inside a substantial quay wall.

The usual trial holes were dug to a depth of 3 ft. below the bottom level of the foundations. A good hard subsoil was exposed which was considered firm enough to carry the super-imposed load of ·6 tons per square foot without danger of subsidence. Owing to the uncertain nature of the site, the widths of the foundations had been designed at 5 ft. under the piers and 4 ft. under the intermediate walling, in order to bring the pressure on the subsoil to a low figure.

The foundation trenches were dug out and, on the whole, appeared satisfactory. Before laying the concrete bed, the drainage ejector pit was excavated. This had been sited at a point about 50 yards further away from the sea and was 6 feet deeper than the building foundations. It was at once evident that there was a soft stratum about 4 ft. below the latter. The whole of the trenches were accordingly tested by driving a Norton Well Tube at 15 feet intervals. In some cases, the tube sank too easily for safety. It was accordingly decided to pile, and 50 heavy 4-in. cast-iron pipes were driven down to solid rock, which was found 10 feet below the trenches. These piles were shod with a loose conical cast-iron point and driven with a 3-cwt. monkey running on a length of 1¼-in. galvanized water-tubing set inside the pipe, on the same principle as the Norton Well apparatus. A heavy lead washer was used to deaden the impact of the monkey and all the piles were successfully driven. The piles were filled with concrete and connected to the concrete foundation with 4 lengths of ½-in. round bar passed down the pipe and bent at right-angles. The foundations, which were already designed to be reinforced with expanded steel, were further strengthened over the piles by two lengths of Decauville rail laid laterally.

The whole of this extra work cost £125, and, as there have been no settlement cracks, the method may be deemed satisfactory as well as economical.

Drainage.—The building is below the level of the main sewerage system and a sewage lift had accordingly to be arranged. A 2-in. Flexala centrifugal pump from the Pulsometer Engineering Co., with a rubber covered impeller and rubber vanes was used. The cast-iron cover of this pump has spiral grooves on the inner face into which solids are pushed by the vanes, which, being of rubber, bend and pass over the obstruction. The solids are then swept by the rush of water into the delivery pipe. The pump has an automatic starting panel with a float switch. Up to the present it has worked without any attention, at a cost of about 1s. 6d. per week for 13 drainage points—W.C.s, lavatory basins, etc.

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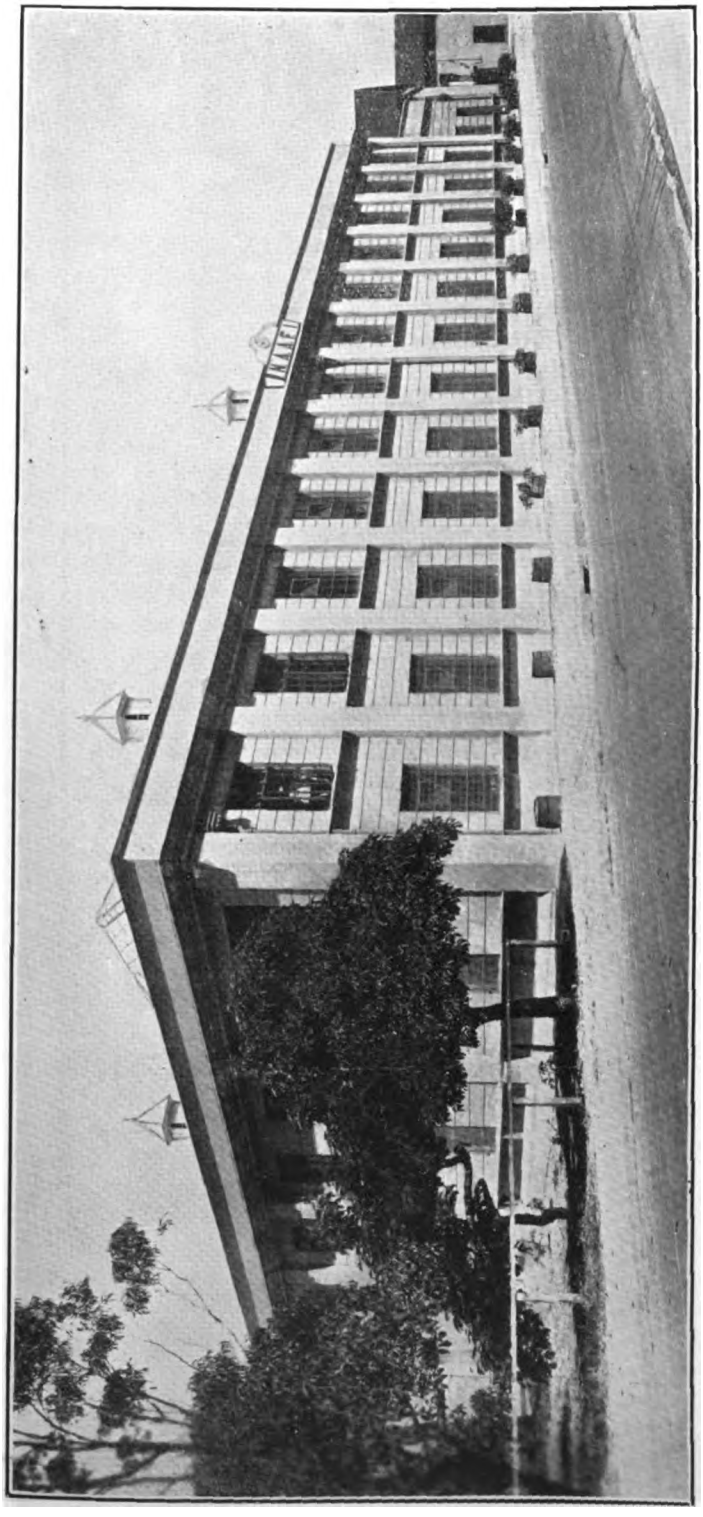
N.A.A.F.I., GIBRALTAR.



Front View

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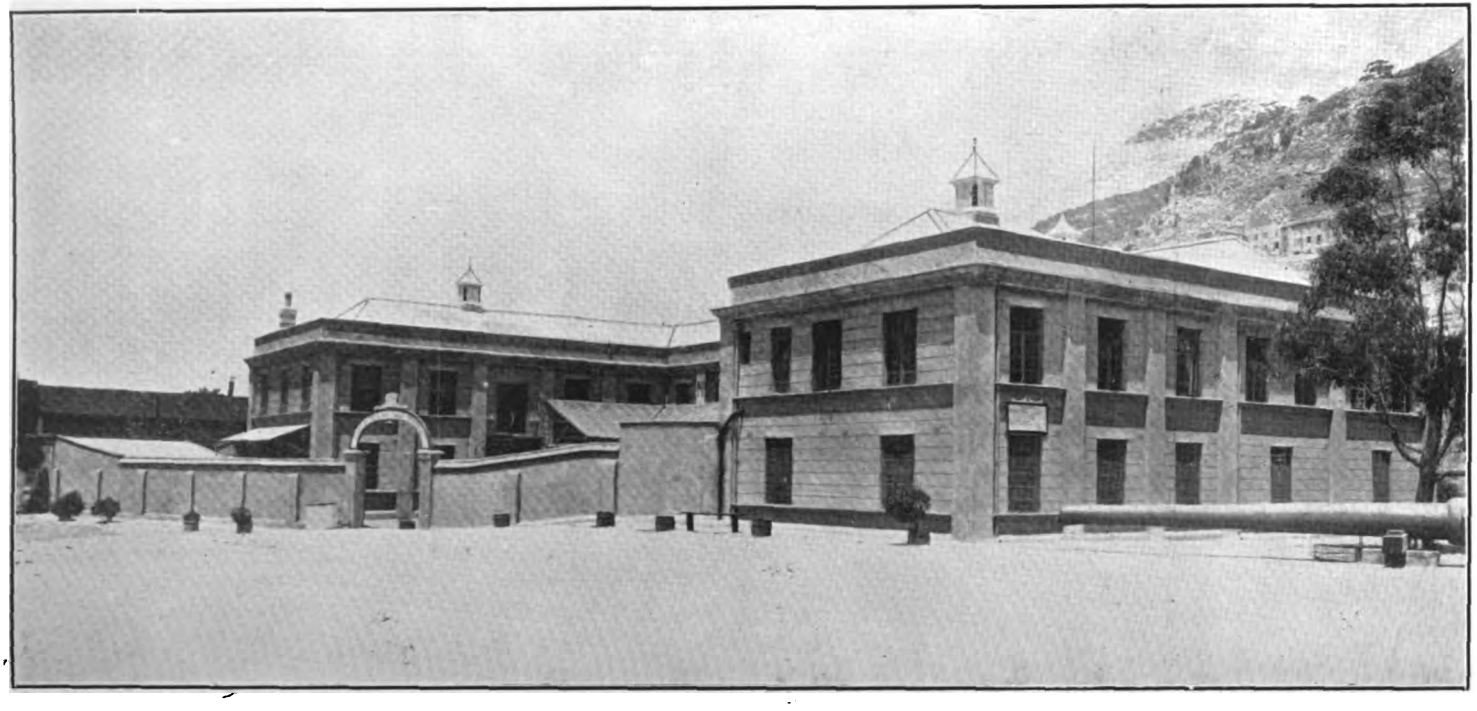

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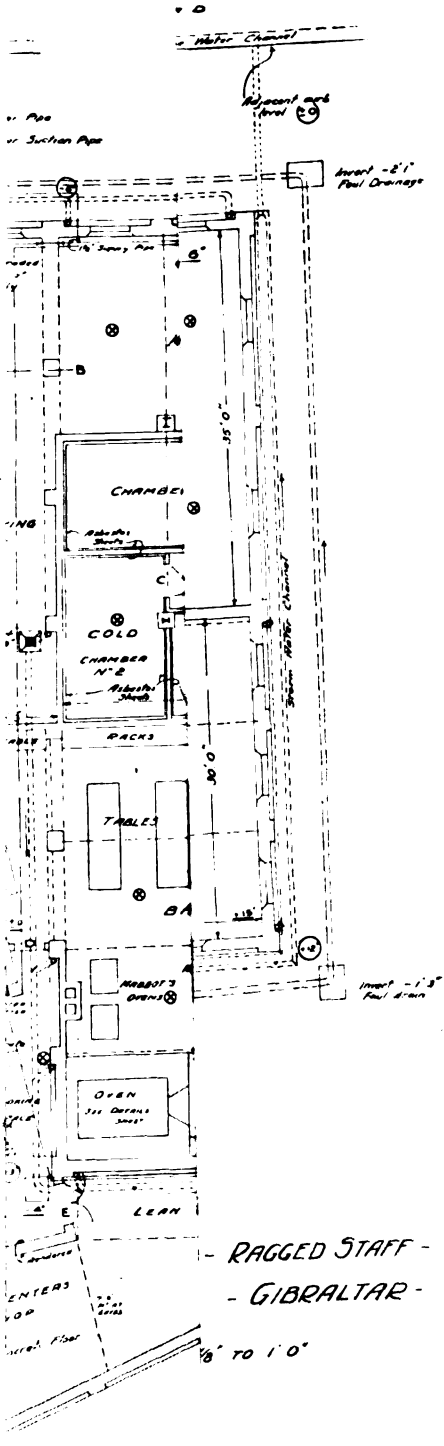

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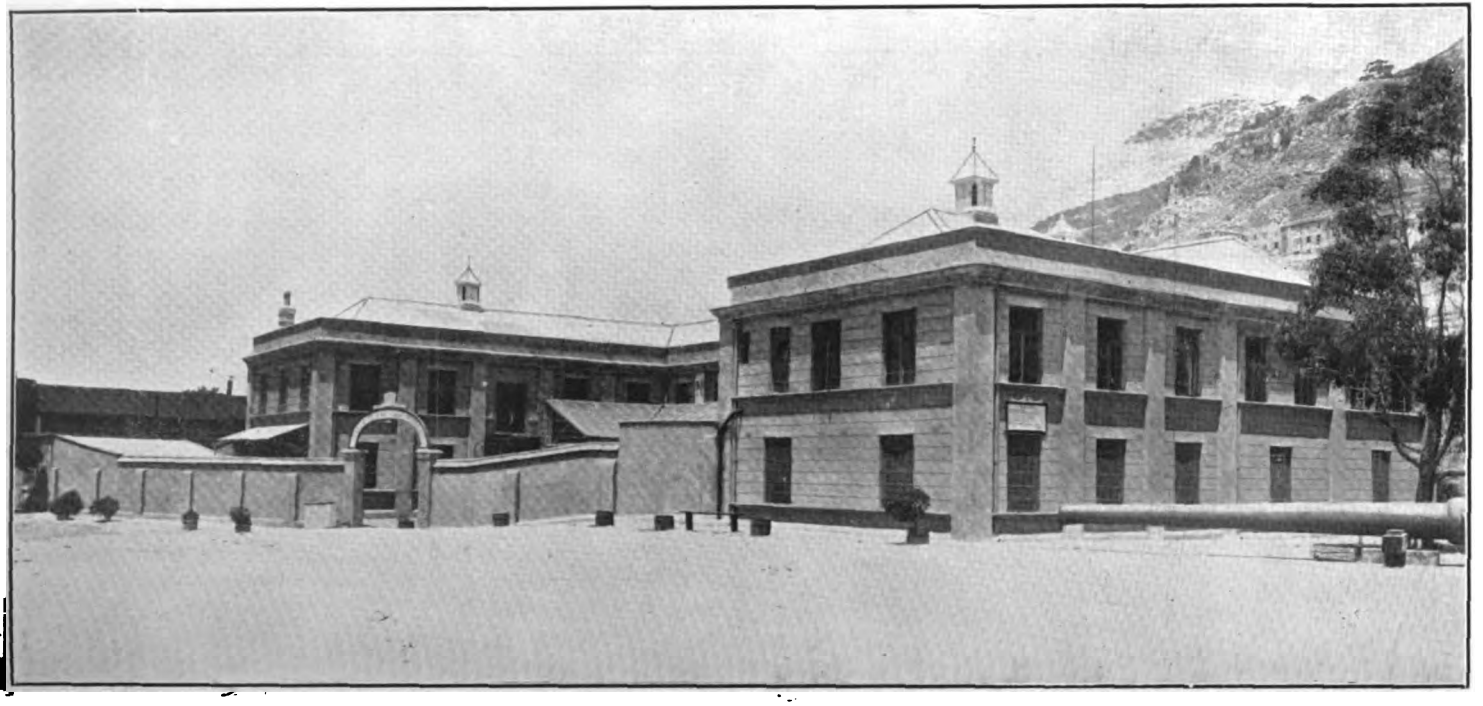

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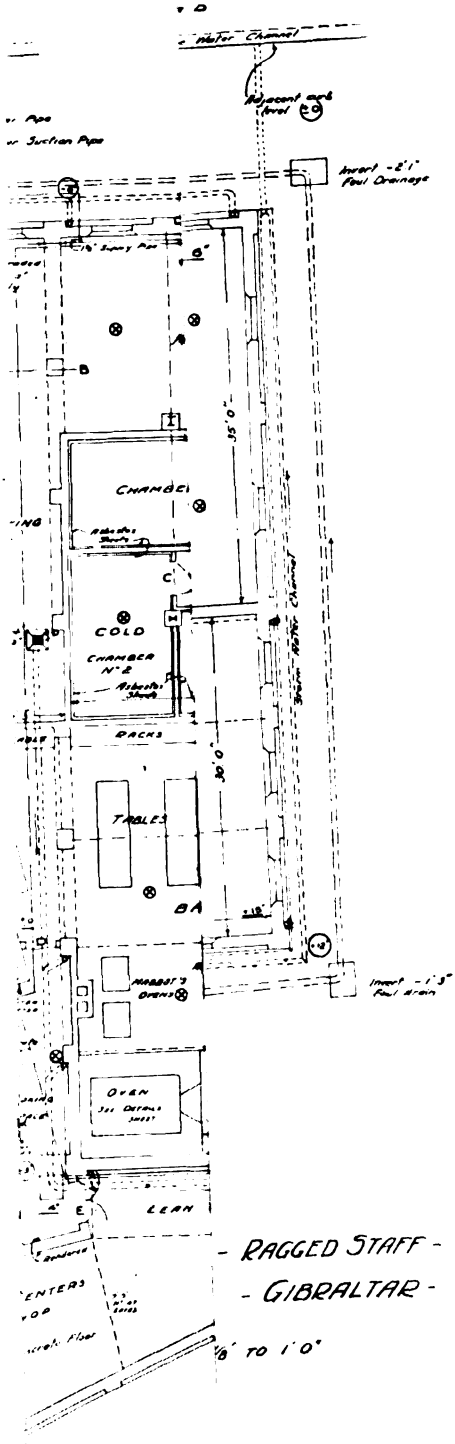

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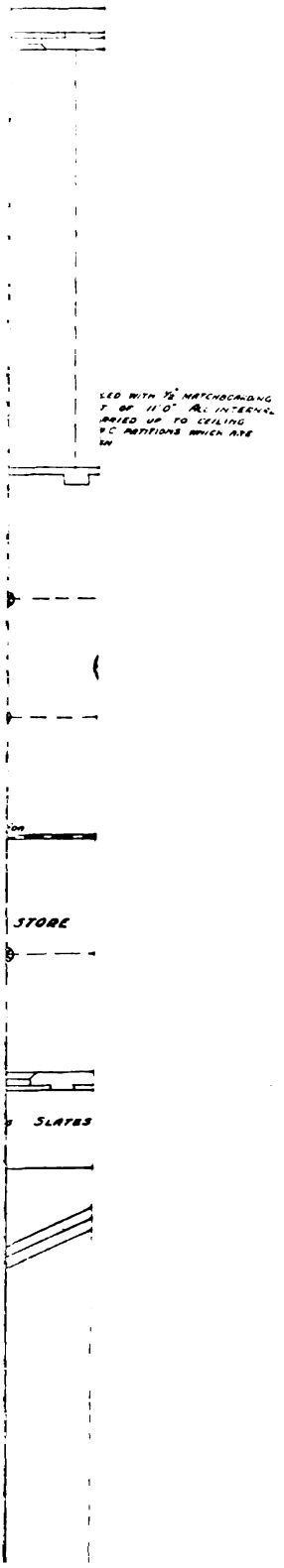

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Bakery.—Efficient ventilation and cleanliness are ensured by large windows and ventilators and high glazed tiled dados and tiled floors. The double-deck, 8 ft. x 6 ft. Collin's baking oven has external furnaces which eliminate furnace dust and most of the heat from the bakery. Flour is fed from the flour loft through a mechanical sifter into the dough mixer, where it is mixed with warm water from the temperating tank. The dough container is then wheeled away to the loaf-making table and an empty container placed in position.

In addition to the Collin's oven, there are two Mabbots' pastry ovens, a mechanical pastry mixer, a pastry roller and cutter, mincer and bun divider, coffee roaster and grinder, all run from separate motors.

Refrigerator.—The chambers, which are sited in the coolest part of the building, are constructed of brick walls rendered, lined with two layers of 3-in. thick pressed, granulated cork slabs, breaking joint, laid and backed in bitumen. The floor and ceiling are similarly treated. The internal finish consists of a tiled floor and cement rendered surfaces on the walls. The cubic capacity of the chambers is 3,700 cubic ft.

The machinery consists of an ammonia compressor with two cylinders, 4-in. diam. and 4-in. stroke, arranged for direct coupling to an electric motor of 12 B.H.P. The condenser is of double-pipe type, 2-in. and 1¼-in. bore. Each chamber has brine tanks with solid-drawn ammonia expansion piping electrically welded and built into grids. Air fans are used for air circulation. An ice tank for 24/54 lb. ice blocks is installed outside the chambers.

Mineral Water Factory.—The fresh water used for minerals is collected from the roofs of the warehouse and led through 6-in. and 4-in. heavy cast-iron pipes to a large concrete tank of 98,000 gallons capacity, from whence it is pumped by a small electrical pump, through 1½-in. galvanized water pipes to tanks above the mineral water factory, passing through filters on the way. Direct supply from these tanks to each machine is given. The machines consist of gas generator and gasometer, bottle washer with jets and brushes for cleaning six bottles simultaneously, syruper, filling machines, syphon filler and corking machines, all run by belting and shafting from a 7 H.P. dynamo. Special protection had to be given to the brickwork near the gas generator, as it was found that the gases decomposed the cement mortar, causing the tiles to fall off the walls. This was effected by fixing a lead apron of 5-lb. lead to the wall behind the generator.

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THE WORK OF A MECHANIZED FIELD COMPANY DURING DIVISIONAL TRAINING.

By LIEUT. J. C. R. FITZGERALD-LOMBARD, R.E.

THE 17th Field Company, which has been mechanized, normally works with the Armoured Force, but during the 3rd Divisional Training this year the Armoured Force was broken up, and this company worked with the 3rd Division. As it is possible that other field companies may be mechanized in the near future, an account of this work may be of interest. The training took place on Salisbury Plain from the 10th–13th September. Roughly, the troops were divided into a Southern Force, consisting of two Infantry Brigades, two companies of tanks and one of armoured cars, two Brigades of Field Artillery and two Field Companies, and a Northern Force, in which were a cavalry brigade, two battalions of mechanized infantry, one company of armoured cars, one brigade of field artillery, and a field troop R.E. The Northern Force, though smaller and more mixed, was thus far more mobile than the Southern, but the latter could count on support from an imaginary brigade—supposed to be detraining at Andover. The Southern Force was being sent up to extend the left flank of the main army, and was given as objective the high ground overlooking the Pewsey Vale, whilst the Northern Force were to deny this and to threaten the Southern communications with Andover.

As regards R.E., the Northern Force, as already mentioned, had nothing but a field troop from Aldershot, whereas the Southern Force had the 17th and 54th Field Companies, and a Field Park Company improvised from the 17th Field Company bridging equipment, and some extra vehicles and stores. We thus get a mechanized field company working with a non-mechanized company in a non-mechanized force against an enemy who were partly mechanized and wholly mobile. This gave a very interesting opportunity for studying the advantages of mechanization as regards R.E. work, and we were fortunate in that the C.R.E. gave us plenty of work, so that we could display these advantages.

On this occasion Lieut. Clarke commanded the 17th Field Company and Lieut.-Colonel Martel was acting as C.R.E.

For those who do not already know it, a mechanized field company in peace consists of four sections, each of two light six-wheel lorries carrying twelve men each, and one six-wheel tool lorry per half-

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company. A compressor and some power tools are to be kept at present at company headquarters, and sent out to sections as required, though, when we know more about their capabilities, they may be included in the section equipment. Company headquarters has a six-wheel reconnaissance car, and the usual vehicles, such as water lorry and cooks' lorry. The bridging equipment of the improvised Field Park Company was organized in four sections, and since all bridging operations were dependent on this company, it is worth while considering it in detail. The first two sections each consisted of two medium six-wheel lorries and trailers and a medium lorry with ordinary body. Each six-wheeler and trailer carried two pontoons and one bay of medium superstructure, whilst the other lorry carried the third bay of superstructure and the shore ends. Each section could thus construct three bays of medium bridge. No. 3 Section had two kapok rafts for ferrying any loads up to three tons—one carried on a Morris " Carrymore " eight-wheeler, and one on a medium six-wheeler, and in addition a lorry carrying stores for converting one of the medium bridges into a heavy bridge if desired. The fourth section consisted of three light lorries—hired from civilian firms for the occasion—each carrying 104 ft. of kapok assault bridge.

The bridging capabilities of this company for the operations may thus be summarized as 63 ft. of heavy bridge, 63 ft. of medium bridge, two kapok rafts, and 312 ft. of assault bridging.

The present scale of bridging equipment carried by a Field Park Company comprises (*a*) trestle equipment, sufficient to make alternatively 63 ft. of medium bridge or 42 ft. of heavy bridge, and (*b*) 416 ft. of kapok assault bridge. It was assumed that the additional equipment necessary to complete the total carried in this instance had been allotted from the Pontoon Bridge Park.

Operations were timed to start at 1500 hours on September 11th, and at that time the Southern Force was in a bivouac area near Weyhill, whilst the Northern Force was near Market Lavington. The Southern Force advanced in two brigade columns towards the Avon. The 54th Company were allotted to the left column, but the right column only had a section of the 17th Company—in fact, up to about 2000 hours there was only a reconnaissance party—the remainder of the company and the Field Park Company being kept back near Division H.Q. The C.R.E. knew that it could be sent up immediately where required, and he would have done the same thing with the 54th Company had it been mechanized.

Briefly, the narrative of the operations was as follows. Both columns advanced, meeting armoured cars and cavalry patrols, but neither encountered any serious opposition. On reaching the River Avon, it was found that all bridges between Upavon and Netheravon inclusive had been destroyed. The left column, however, succeeded in securing a bridge at " C " Crossing, and crossed the

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river that evening; the right column forced a passage across the river near Netheravon early in the morning on the 11th. During the morning of the 11th, the advance was continued, and the Northern mobile force again harried and delayed the progress of the Southern Force. At this stage the Southern Force Commander anticipated that the enemy might endeavour to carry out a turning movement round his left flank, and he therefore destroyed all bridges at and south of Bulford, and ordered reconnaissances to be carried out with a view to establishing a line of communication further north. The Southern Force reached their objective on the high ground overlooking the Pewsey Vale early on the 12th. It was now found that the Northern Force, who had only been fighting a weak delaying action, were concentrating about Shrewton. Southern Force were preparing to move their communications further north, when the Southern Force Commander received the information that the detrainment of the imaginary infantry brigade at Andover had been delayed 24 hours owing to bombing, and that consequently he was to secure the high ground west of Upavon and to move his line of communication with Andover further north in order to shorten it. This was done during the afternoon of the 12th, but late that evening he received information that the advance of this brigade was cancelled altogether, and that he was to withdraw on Andover. The movement was commenced at daybreak next day, and by noon, his troops being near Tidworth, operations were concluded.

As far as R.E. work is concerned, these operations may be divided into three phases, the advance, the movement of the line of communication, and the withdrawal.

Considering the first of these, the 54th Company had little to do, except water supply, since the left column reached the Avon just in time to save the bridge from demolition, and crossed at once. The company were thus unable to use the assault bridges, which had been sent up to them that evening.

The advanced section of the 17th Company, however, handed over assault bridges to the right column, and these were used, on the morning of the 11th, by the Duke of Wellington's Regiment to cross near "B" Crossing.

A little later, they used a kapok raft, and the machine-guns and a light battery were rafted over to support the leading troops and enable them to enlarge the bridgehead.

The pontoon bridging equipment had been kept back near Divisional Headquarters, about four miles from the river, and, at 0730 hours, orders were issued for the construction of a medium bridge near "B" Crossing. The remainder of the 17th Field Company were sent forward with No. 1 Section of the bridging equipment from the Field Park Company, and they moved cross-country direct to "B" Crossing. Work on the bridge construction started at 0830 hours,

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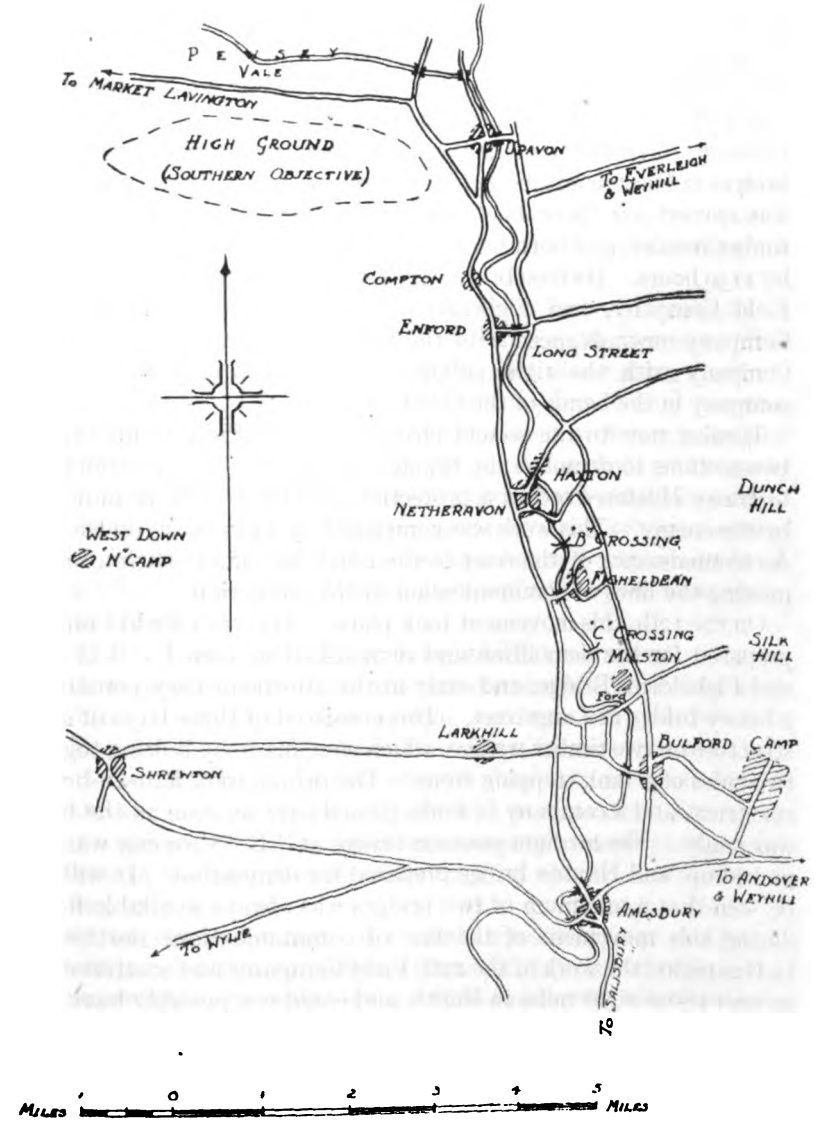

3RD DIVISIONAL EXERCISE

MAP SHOWING CROSSINGS OVER RIVER AVON

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and the bridge, which consisted of three bays of medium bridge on two medium pontoon piers, was completed by 0855 hours. The remainder of the right column crossed by this bridge during the morning.

The position was now that the South Force was advancing over the river with a heavy bridge at " C " Crossing (an existing bridge that had not been demolished) and a medium pontoon bridge at " B " Crossing. In order to make the position more secure, the demolished bridges at Haxton and Figheldean were ordered to be repaired. This was carried out theoretically by using pontoon superstructure on timber trestles, and both bridges were passed by the umpires as open by 1130 hours. Haxton bridge was repaired by one section from 17th Field Company, and Figheldean by 54th Field Company. 54th Company now advanced with the left column and one section 17th Company with the right column, leaving the remainder of this company in the hands of the C.R.E.

Turning now to the second phase, the 17th Field Company sent two sections to demolish the bridges at Bulford and Amesbury, and to crater Hilston Ford as a protection against a turning movement by the enemy. This work was completed by 1330 hours on the 11th. A reconnaissance of the river to the north was made with a view to moving the lines of communication in that direction.

On the 12th, this movement took place. The 17th Field Company prepared for the demolition and demolished in turn " C " Crossing and Figheldean Bridge, and early in the afternoon they constructed a heavy bridge at Longstreet. This consisted of three bays of superstructure on two timber trestles, which were made by bolting together two sides of a tank stepping stone. The bridge took half-an-hour to construct, and a company of tanks passed over as soon as the bridge was ready. The medium pontoon bridge at " B " Crossing was then picked up, and Haxton bridge prepared for demolition. It will thus be seen that a minimum of two bridges was always available for use during this movement of the line of communications northwards. In this period the work of the 17th Field Company was scattered over an area about eight miles in length, and could not possibly have been done in this time by an unmechanized unit. The 54th Field Company had meanwhile been busy with water supply arrangements, and had erected a water point for the 9th Brigade at West Down North Camp, and, later, another at Compton Farm.

In the withdrawal which was ordered on the 13th, the 17th Company prepared the bridges at Upavon, Enford, and Longstreet for demolition, and blew them up after all troops had crossed, whilst the 54th Company destroyed the bridge at Haxton, which had previously been prepared for demolition by the 17th Company. All demolition parties had rejoined their units by 0900 hours on the 13th, and soon afterwards operations were brought to a close.

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The operations provided a thorough test for the company vehicles. When the company was first mechanized—nearly three years ago—there were many alternative suggestions for the type of vehicle to be adopted, such as half-track lorries, and larger and more powerful vehicles, but the trials have so far completely justified the selection of the light six-wheel lorry as the standard vehicle for a mechanized field company. The question has arisen as to whether two Morris "Carrymores" would not be better than a Guy and trailer for carrying the double pontoon and bay of superstructure. In these operations the Guys ran very well, and were able to go where required, but the impossibility of backing them, except by manhandling the trailers, should not be forgotten.

The lack of a mechanized cooker, which is not yet available for mechanized units, was particularly in evidence on the first day. The 54th Company arrived at the assembly point about three-quarters-of-an-hour after us, and yet had dinners going within about a quarter-of-an-hour; whereas it took us about two hours from our time of arrival to light fires and get the dinners cooked. As regards the tool lorries, the one provided with a derrick proved its usefulness at Enford by pulling out a refractory gate-post when we were clearing a way to the heavy bridge. The arrangement and contents of these lorries left little to be desired—they contained all the tools we wanted, stored in accessible positions.

The heavy bridge at Enford, over which a company of tanks passed, provided a good test for the timber trestles. They were used in a shallow river with a firm bottom, and were very successful—showing no tendency to capsize. The bridge, however, is rather too narrow for tanks, which, unless steered absolutely straight, fouled and broke the racking chains. Tanks had to cross dead slow at as constant a speed as possible, and it was necessary to employ a maintenance party of six men looking after racking chains and stiffeners while they were crossing.

In general, the advantages of a mechanized company stood out prominently. Besides rapidity of movement from one place to another, mechanization enabled the C.R.E. to keep the company near Division H.Q. from which sections could be sent out on jobs, such as demolishing or repairing a bridge, at short notice as required. On completion, the section rejoined the company, and was immediately available for another job if required. This procedure would be difficult—if not impossible—with a non-mechanized company, and this is exemplified if a comparison is made of the bridging and demolition work done by the two field companies in these operations.

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SHAKESPEARE AND ELIZABETHAN WAR PROPAGANDA.

By COL. B. R. WARD, C.M.G., Hon. Secretary, "The Shakespeare Fellowship."

THE Elizabethan era was admittedly great both in arts and arms, culminating, as regards the former, in Shakespeare, and, as regards the latter, in the naval victory of 1588. An intimate bond unites the Elizabethan dramatists with the Spanish War; but this has not been hitherto suspected, chiefly because the earliest Shakespeare quarto was not published until 1593, five years after the defeat of the Armada.

Froude originally designed his famous history to extend from the commencement of the personal rule of Henry VIII. to the death of Elizabeth. The title he eventually decided on was *A History of England from the Fall of Wolsey to the Defeat of the Spanish Armada.* One result of this change of plan on his part has been to convey the impression that the war against Philip II. ended in a clap of thunder in 1588, and that during the remaining fifteen years of Elizabeth's reign the country was in the enjoyment of peace and quiet. Nothing could be further from the truth.

"The Shakespeare Fellowship," founded six years ago with the object of carrying out research work, in order to throw light on the many Shakespeare problems that still await solution, has for the last three years extended the field of its researches so as to include the general history of the time. Literary problems, we have found, cannot be studied apart from questions of social environment; and the results of our investigation will, we believe, throw a new and interesting light on a period which has been hitherto much misunderstood.

When Queen Elizabeth came to the throne she inherited an empty treasury, a debased coinage, a war with France, and a realm torn asunder by the bitter controversy between Lutheranism and Catholicism. Her first step was to conclude a treaty of peace with France; her second was to dissolve the religious controversy by the compromise known as the Elizabethan Religious Settlement; her third was to restore the currency; and her fourth was to replenish the Exchequer.

For the first twenty-seven years of her reign, England enjoyed almost unbroken peace, and in its wake followed prosperity. During

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the same period, the rival monarchies of France and Spain underwent a much less fortunate destiny. France was being gradually suffocated into bankruptcy by an interminable series of religious civil wars; and Spain was steadily squandering her vast resources in a vain attempt to subdue the rebellious Dutch burghers. All this time, Elizabeth and her Lord Treasurer watched, prepared, and waited. At length, when they judged the moment ripe, they threw down the challenge to the Spanish giant.

Early in 1585, the Queen received an embassy from the Dutch Republic, and agreed to send over a Royal Army of 4,000 men to co-operate with them against the Spaniards. In August, this little expeditionary force landed in Holland, with the Earl of Oxford as General of the Horse, and Sir John Norris as Colonel of the Foot. Six weeks later, Lord Oxford was unexpectedly and mysteriously recalled; and in December, the Earl of Leicester, at the head of a large body of reinforcements, took over supreme command as Lieutenant-General of Her Majesty's Army in the Low Countries.

It was in no light-hearted spirit that the Queen and Lord Burghley entered into a death-struggle with Spain. For years they had employed every diplomatic device to postpone the declaration of war; but, once the issue was joined, they prosecuted the war with the utmost vigour and determination. It is impossible here to give even the barest outline of the naval and military operations that took place during the ensuing seventeen years. But an attempt will be made to indicate a few parallels between the effect of the war on the Elizabethan civil population and our own experiences in 1914–18.

From 1558 to 1588 taxation had remained at a fairly constant level. In 1589 it was doubled, in 1597 it was trebled, and in 1601 it was quadrupled. This approximates closely to our own recent experiences, with a pre-war budget of about £200,000,000 and a post-war budget of about £800,000,000.

Between 1593 and 1596, the price of wheat was very nearly trebled, and in the latter year the scarcity of foodstuffs amounted almost to a famine. Once again this corresponds closely to the rise in prices between 1914 and 1917, and to the critical food shortage in the latter year. No one who remembers the bread queues during the Great War would probably deny that crushing taxation, soaring food prices, and even the threat of scarcity, are the surest and quickest means of undermining the morale of the civilian population. From the parallels I have drawn, we may be quite sure that the burdens and tribulations of our Elizabethan ancestors were not a whit less than those we underwent in 1914–18.

During the seventeen years that the war lasted, the annual direct expenditure on the Army and Navy alone exceeded 80 per cent. of the total revenue of the country on no fewer than seven occasions;

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and at the time of the Armada crisis—1587 and 1588—the figures are 95 per cent. and 101 per cent. respectively. In one year only —1595—did the naval and military expenditure drop below 50 per cent. of the revenue. These figures, moreover, do not take into consideration extraordinary expenditure due indirectly to the war.

Over and above the direct and indirect cost of the war, the Queen had to maintain the normal routine expenses of running the Court and Country. The Chamber, the Household, Gentlemen Pensioners, Civil Servants' salaries, the Office of Works, etc., etc., all had to be kept going. When we realize that the average annual cost of maintaining all these multifarious services was less than £100,000, we begin to understand why it is that Elizabeth has acquired such a reputation for economy and thrift. Between 1585 and 1602, the war expenditure multiplied itself by four; but during the same period the salaries and pensions of Civil Servants and Crown dependants fell from over £20,000 a year to £14,000 a year. And this in the face of ever rising food prices.

Truly it was no light load that Queen Elizabeth imposed upon her subjects at home. There were no war-bonuses in those days. Every penny that could be scraped together went to satisfy the ever-increasing demands of the Army and Navy.

It is probably true to say that one of the gravest concerns of our Cabinet during the War with Germany was how to prevent the gradual demoralization of the home front. Germany's defeat was largely due to the eventual collapse of the civil population under the intolerable strain they had to bear. The ultimate defeat of the Spaniards by the England of Elizabeth was due in no small measure to the fact that the morale of the overburdened tax-paying peasants of Castile completely broke down, and their once fertile valleys became desolate wildernesses. Why did King Philip fail where Elizabeth succeeded? Why did the Spanish home front collapse while ours held firm?

There was probably little to choose, in the sixteenth century, between the sturdiness of Spanish and English stock; there was, perhaps, not very much difference between the burden each nation had to bear; and, even if we assume Elizabeth's superior genius for economy, we must also admit that Philip II. was very far from being recklessly extravagant. Perhaps the real secret of Elizabeth's success lay in her appreciation of the needs of the home front, and in the genius she exercised in holding together and inspiring her war-worn subjects, who were labouring under so great a strain of taxation, high prices, and scarcity.

Let us examine a few of the incidents in the opening days of our own Great War, and see how they may be paralleled with similar happenings in the early months of the Elizabethan struggle.

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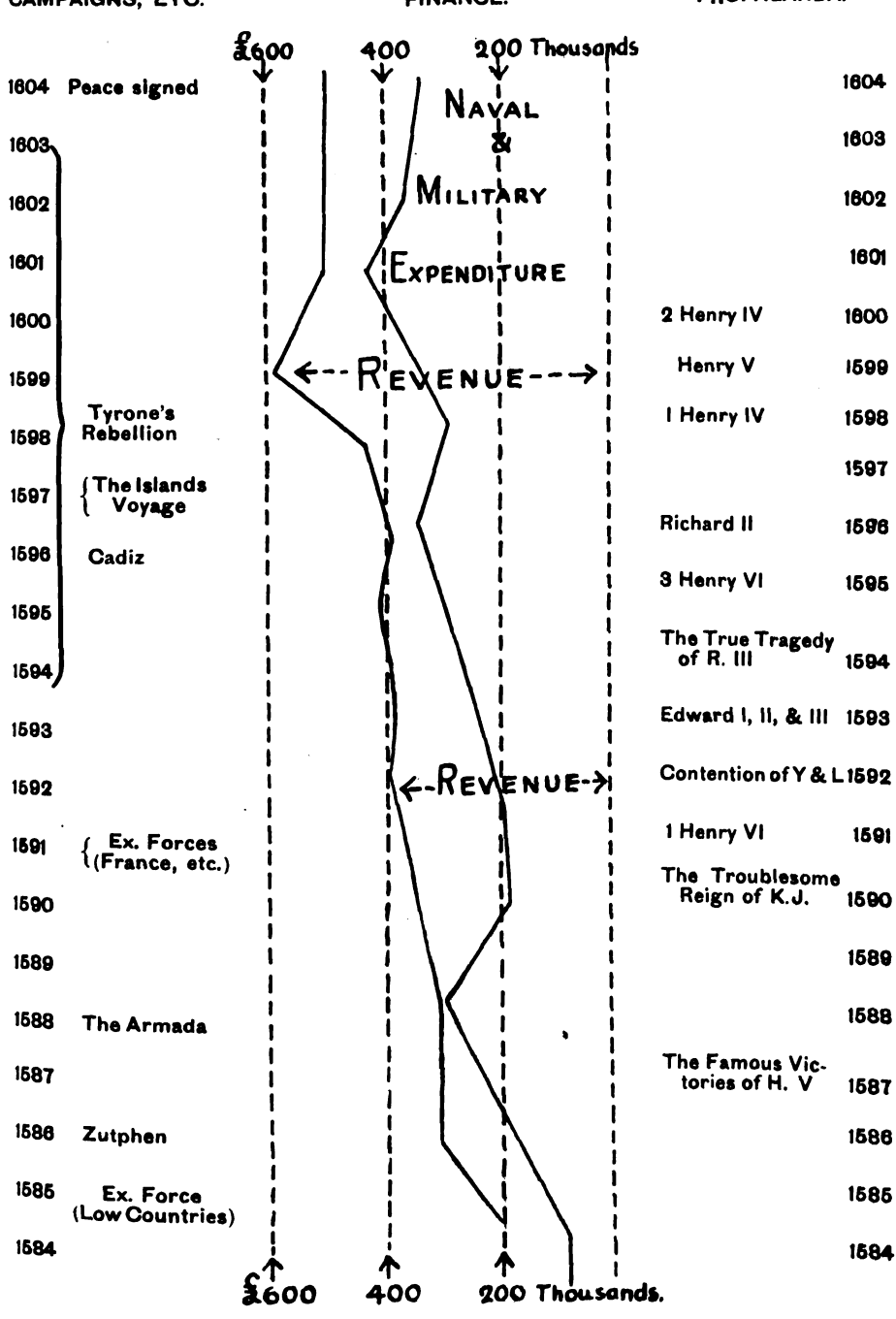
ANGLO-SPANISH WAR, 1585—1604.



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On 7th August, 1914, three days after the declaration of war, the Press Bureau was established by Lord Kitchener, with Lord Birkenhead as its first Director. The censoring of undesirable news was the first and most important of its duties. Shortly afterwards it was found that Government control of a positive kind was also necessary if the morale of the nation was to be maintained. A War Propaganda Bureau was accordingly set up by the Prime Minister. In February, 1918, this Bureau was enlarged by the appointment of Lord Northcliffe to the important position of Director of Propaganda in Enemy Countries. Combined with the voluntary work of the great newspapers, these two public departments of censorship and propaganda exercised, throughout the War, a continuous and effective pressure on public opinion at home and abroad.

During the opening stages of the Elizabethan War we may well imagine that administrative action similar to that taken in 1914 may have been necessary; and, indeed, we find this to be the case. The Earl of Oxford had not been more than six weeks in the Low Countries before he was recalled by the Queen's orders, and the Earl of Leicester appointed to the command. It seems probable that the Queen had come to the conclusion that the home front was more likely to provide opportunities for his special talents than a military command overseas. It was in October, 1585, that he was recalled; and the war had only lasted eight months when the Queen took the identical two steps that were taken in 1914 by Lord Kitchener and the Prime Minister.

Having found that too much liberty given to the printing press was causing grave inconveniences, she empowered Archbishop Whitgift and the Privy Council to draw up rules regarding printing. A Star Chamber decree was accordingly issued on 23rd June, 1586, of which the following were the principal provisions:

1. Every printer in possession of a press was ordered to report details to the Wardens of the Stationers' Company within ten days.
2. Printing was only to be allowed in London, Oxford and Cambridge. Presses were to be examined periodically by the Stationers' Company.
3. No one was allowed to print any book, work, copy, matter or thing whatsoever until it had first been seen and perused by the Archbishop of Canterbury or the Bishop of London. The only exception to this rule was made in favour of the Queen's printer, who might carry out any duties specially ordered by Her Majesty or the Privy Council.
4. Nothing was to be printed against the form or meaning of any restraint or ordinance contained in any statute or law of the realm, or against the true intent and meaning of any letters patent, commissions, or prohibitions under the Great Seal of England.

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It is clear from the foregoing that the Queen realized that in time of war it was more than ever necessary for the Government to exercise a severe and rigid control over the printing press.

Just as in the Great War a Press Bureau for censorship duties was shortly followed by a Propaganda Bureau for disseminating information calculated to encourage loyalty to the Government and patriotic feeling, so we find within three days of the issue of the Star Chamber decree, which detailed pains and penalties that would follow any infringement of censorship regulations, that a Privy Seal Warrant was signed by the Queen granting " to Our right trustie and right welbeloved Cousyn the Earle of Oxford " a payment of £1,000 yearly. The wording of this warrant was couched in the same phraseology as that employed in the case of secret service money, the Exchequer officials being expressly forbidden to call for any account as to its expenditure. We know, moreover, that it was granted for some State service because it is not included with the ordinary annuities in Part I of the Exchequer accounts, but is entered in Part XIII, which consists of payments to the heads of the various State departments. And Lord Oxford received the grant regularly from 1586 to 1604—a period which corresponds exactly with the duration of the Anglo-Spanish War.

It seems reasonable to suppose that this grant was made for the same purpose as that effected by the establishment of the Propaganda Department in the Great War. In Elizabethan days there were no newspapers, and public opinion was influenced partly by the issue of authorized Government pamphlets, or mainly—since reading was a rare accomplishment—by Government control of stage plays, particularly by the exploitation of the now famous Elizabethan historical dramas.

It has been recognized for a long time that a remarkable unanimity of style and sentiment can be traced in the work of the dramatists of the fifteen-nineties—*e.g.* Shakespeare, Marlowe, Peel, etc.—but the cause of this widespread unanimity has been a puzzle. It is not difficult for us, with the experience of the Great War behind us, to see that this unanimity of thought behind the printed dramas of the Spanish War period was almost certainly due to some form of Government control. In time of war, the individuality and independence of the subject have to be subordinated to the needs of the nation ; the Elizabethan dramatists were, in effect, employed on a most important branch of national service at home.

All through the first part of her reign the Queen had shown, by her frequent progresses through the country, the importance she attached to personal contact as a means of influencing public opinion in favour of her authority. In time of war, no doubt, she found it desirable to supplement this personal propaganda by the use of mass suggestion, effected mainly by means of the stage. Miss Clemence

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Dane, in her fine play, *Will Shakespeare*, first acted in November, 1921, correctly sensed the situation in the scene which represents the Queen giving Shakespeare instructions as to his work:

Elizabeth. I send my ships where ships have never sailed,
To break the barriers and make wide the ways
For the after world.
Send you your ships to the hidden lands of the soul,
To break the barriers and make plain the ways
Between man and man.

This scene is symbolically true. Shakespeare stands for all the dramatists of the war period, acting under the impulse given by the Queen through her chosen representative the Earl of Oxford.

An instance of how Lord Oxford carried out the Queen's secret instructions may be seen from the following example. On 3rd February, 1594, the Privy Council wrote as follows to the Lord Mayor of London:

To our very good L. mr. Alderman Buckle, L. Maior of the Citie of London.

For restraint of playes.

After our very hartie commendations to your L. Whearas certein infourmation is given that very great multitudes of all sorts of people do daylie frequent and resort to common playes lately again set vp in & about London, whearby it is vpon good cause feared that the dangerous infection of the plague, by Gods great mercy and goodnes well slaked, may again very dangerously encrease and break foorth. . . . Wee thearfore thought it very expedient to require your L. foorthwith to take strait order that thear bee no more publique playes or enterludes exercised by any Compaine whatsoever within the compas of five miles distance from London, till vpon better lykelyhood and assurance of health farther direction may bee giuen from vs to the contrary.

Your L. very louing friends,

Io : Cant.	Io : Puckering.	C. Howard.
Th. Buckhurst.	R. Cecyll.	I. Fortescue.

As a general rule, the Lord Mayor and Aldermen of London required no prompting from the Privy Council to induce them to exercise their authority in restraint of plays. They were only too ready to snatch at any opportunity to stop these performances, hateful as they were to the Puritan element in the population and also to employers of labour who looked upon stage plays as an encouragement to idle apprentices to shirk their work. It should also be noted that an important member of the Council—Lord Burghley—was not one of those who signed this letter to the Lord Mayor.

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Now, on 7th July, 1594—just five months later—the Earl of Oxford wrote as follows to his father-in-law, Lord Burghley:

> My very good Lord:
>
> If it please you to remember that about half a year or thereabout past, I was a suitor to your Lordship for your favour: that, whereas I found sundry abuses whereby both Her Majesty and myself were in my office greatly hindered, that it might please your Lordship that I might find such favour from you that I might have the same redressed. . . . In which doing I shall think myself singularly beholden in this, as I have been in other respects. This 7th of July.
>
> Your Lordship's ever to command.
>
> EDWARD OXENFORD.

It seems probable that Oxford was here protesting that his stage propaganda work was suffering owing to the action of the Privy Council, a body from whom he would naturally expect support and not hindrance against the inveterate hostility of the City authorities.

In 1604, while the peace negotiations with Spain were in progress, the Earl of Oxford died The preceding eighteen years had witnessed a remarkable vogue for the war-like chronicle play; Marlowe, Shakespeare, and other dramatists whose names have not come down to us, all contributing their quota. And, with the conclusion of peace, this vogue for historical drama ceased as suddenly as it had begun. Does it not follow that these plays represent, in the main, Elizabethan war propaganda as far as the stage is concerned?

After all, it is not very extraordinary to find that Queen Elizabeth subsidized and utilized the drama in this way. She herself was passionately devoted to plays; and there seems no reason to doubt that she would fully appreciate the propaganda value of the stage in the days before newspapers and wireless. The following examples give some idea of the range of war-like propaganda to be found in the Chronicle plays:

1. The invincibility of English arms is dealt with in the *Famous Victories*, *Henry V.*, and *Edward I.*
2. The encouragement of patriotism and anti-Catholicism are dealt with in the *Troublesome Reign* and *King John.*
3. The fate of disloyalty is shown by the execution of the regicide Mortimer in the last scene of *Edward II.*
4. Loyalty to the reigning house—(the Tudors sprang from the House of Lancaster)—is dealt with by exalting the Lancastrians and vilifying the Yorkists in the *Contention*, the *True Tragedy*, *Henry VI.*, and *Richard III.*

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5. The inevitable fate of rebels is exemplified by the collapse of Cade's rebellion in *Henry VI.*

6. Anti-Spanish propaganda is the main theme of *Edward I.*

These instances are by no means exhaustive; nor is it suggested that these plays are wholly concerned with propaganda. The primary object of the plays was to interest, amuse, and entertain. The propaganda *motifs* are, as it were, slipped in quite casually. And it is significant that the direct propaganda appeals are usually to be found in the first and last scenes, where they obviously would have the greatest effect on the audiences. It is not, of course, suggested that all these plays necessarily emanated from Lord Oxford's department of State; his task, as head of such a department, would more probably have been to encourage dramatists to write plays of a patriotic character.

An interesting example of the use of the stage for subversive propaganda occurs in the following well-known story. It is said that the deposition scene in *Richard II.*—a scene which caused Elizabeth to exclaim: "Do you not know that I am Richard II.?" was not part of the original play, but was specially written and acted at the instigation of Lord Southampton just before the Essex rising.

When we compare the Elizabethan stage during the Spanish War with our own during the Great War, it is curious to find a very close parallel in the case of two favourite soldier characters. Old Bill, as a representative of the men affectionately known as "the Old Contemptibles," is characteristically an English hero by the very absence of the obviously heroic virtues. None the less is he the best-known symbol of the finest Army that ever left our shores. Falstaff in the same way represents one of the many captains whose deeds have been mostly forgotten, but who carried on the professional soldierly tradition, under Lord Oxford's famous cousins, the "Fighting Veres," his brother-in-law the "Brave Lord Willoughby," and his old colleague-in-arms, Sir John Norris. Falstaff himself—as we now know from Mr. John Dawtrey's book, *The Falstaff Saga*—had a flesh-and-blood prototype in a fine—though corpulent—soldier, Captain Nicholas Dawtrey, who did excellent work in preparing the levies in 1588, and who died on active service in Ireland in 1601. Falstaff is just as much the heroic Elizabethan captain as Old Bill is the heroic soldier of the retreat from Mons. Their foibles and humours were never intended to detract from their sterling qualities. We laugh at and with them, but we love them all the same; recognizing that they are kindly caricatures of men whose virtue, in the Roman sense, was real and solid. Nor does the parallel between Old Bill and Falstaff finish with their war-time adventures. Shortly after 1918, a play was produced in London called *The Better 'Ole.*

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This play represented Old Bill, demobilized and back again in the bosom of his family, as the happy and contented proprietor of a public house. And there is a well known tradition that about 1602 (when the Spanish War was virtually over) Queen Elizabeth expressed a desire to see Falstaff in love, and that Shakespeare obliged her by writing *The Merry Wives of Windsor*, which represented Old Jack back once more amongst the bar-maids of Windsor.

To sum up. When we remember the perils threatening England from Spain and the Pope on the one hand, and the doubtful succession issue on the other, is it not quite natural that Elizabeth should, in 1586, have conceived the idea of a secretly subsidized State department to assist and control the public theatres, in order that her subjects might not only be encouraged by such spectacles as English victories over foreign nations and a successful revolt against the tyranny of the Pope, but also that it might be brought home to them that loyalty to the anointed sovereign inevitably triumphed over the forces of rebellion?

At any rate, Lord Oxford was given £1,000 a year of public money from 1586 to 1604; and, considering how severe and continuous was the financial pressure throughout the whole period, we may be quite confident that the Queen would never have authorized so large a grant every year from the depleted Exchequer unless she had been thoroughly convinced of the high value of the services rendered by the Propaganda Department. After all, it is not difficult for us to hold the same conviction when we picture how electrified the audiences at the inn-yards and theatres must have been as they listened to the ringing message contained in the closing lines of the anonymous play, *The Troublesome Reign of King John*:

> If England's peers and people join in one,
> Nor Pope, nor France, nor Spain, can do them wrong.

Or, as Shakespeare put it:

> Come the three corners of the world in arms,
> And we shall shock them. Nought shall make us rue,
> If England to itself do stand but true.

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THE FASTNET CUP RACE, 1928.

By CAPTAIN B. E. C. DIXON, M.C., R.E.

As the Yacht Club had received a special grant from the Corps Games Fund towards expenses for the Ocean Race, it was decided that *Ilex* should be entered for the race as usual. No new gear was considered necessary, as a new set of head-sails had had to be purchased after last year's Ocean Race and she was well fitted out last winter. The mainsail, though old, was considered to be strong enough for the race, though it was hoped that similar weather to last year would not be encountered, as it certainly seemed doubtful whether the sail would stand up to it.

Ilex went to Portsmouth on 5th August and, as usual, was scrubbed down and everything put ship-shape by Carter, prior to the crew joining her the day before the race. The crew, consisting of D. N. B. Hunt (*skipper*), D. R. Crone, B. E. C. Dixon, M. T. L. Wilkinson, F. J. P. Gibson, T. W. R. Haycraft and H. S. Francis, joined at Portsmouth on Tuesday, 14th August, and sailed to Cowes, practising taking down a reef on the way.

On 15th August, the crew were up early stowing ship and getting up sail. It was a perfect morning, with a light westerly wind which freshened considerably by 11.30 a.m., the hour fixed for the start of the race. Anchor was weighed at 10.45 and, with full light weather canvas and spinnaker set, Hunt made an excellent start, crossing the line a few seconds after the gun, leading the fleet of the remaining eleven starters by nearly a quarter-of-a-mile. *Ilex* retained the lead for some time by keeping in close to the shore and avoiding the tide. Near Ryde, the wind backed till nearly abeam, and *Nina* and *Mohawk*, the two American schooners, went through our weather as we handed the spinnaker.

By 2.15, we were close hauled on the starboard tack with a fresh wind and choppy sea, and memories of last year's race came to us as we started a dead beat down Channel. *Jolie Brise*, *L'Oiseau Bleu* and *Neptune* soon passed us to leeward. *Nina*, who was pointing up like a racing cutter, was going very fast; and *L'Oiseau Bleu*, from whom we were only getting twenty minutes, looked very dangerous. As the afternoon wore on the fleet spread out, and we settled down for the 600-mile trip. Some of the crew at this stage were feeling by no means happy, but by Thursday morning all had got their sea legs, and there was no further sea-sickness. Hunt divided the crew into two four-hour watches with two dog watches. This was found to be a great improvement on previous years, as it meant a comfortable berth for those off watch.

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At 4.30 p.m., Wilkinson was asked to put his weight on to the topsail sheet. He did so with such effect that the starboard topmast shroud parted, and the topmast and topsail yard crashed towards the deck. *Ilex* was put about and hove to on the port tack to clear the wreckage, the job taking about an hour—sixty minutes of good time wasted, and only plain sail for the rest of the race, unless something could be done.

By 6.35 p.m., we were nearly abeam of the Needles on the starboard tack, and, with a good steady breeze, remained on this tack throughout the night. About 8 p.m., *Lassie* crossed our bows a few cables ahead and shortly after went round on to the starboard tack. She was not carrying a topsail and we learnt afterwards that her topmast had sprung off Bembridge Ledge.

At dawn on Thursday, we were out of sight of land, holding a southerly course on the starboard tack, and it was not until 2 p.m., when the wind, which had now fallen to a light breeze, had backed, that we went about heading into the land.

The previous evening we had got the heel of the topmast down on deck and found that it had broken straight across at the cap, leaving seven feet below, and about ten feet of good wood above the fracture. The topmast shroud, which had parted near the top, looked quite sound, and we therefore had some seventeen feet of good timber and enough wire to stay a shorter topmast if we could rig one. Many suggestions were made during the morning, but none seemed practicable, until Francis, who was below off watch, suddenly decided that he could make a scarf joint if the necessary tools were available. Carter produced them like a magician, and Francis set to work, assisted by the advice of the remainder of the crew. By the evening the topmast was joined by an excellent double-scarf joint, held together by long coach screws and binding wire, and was only about three feet shorter than before it snapped. Doubts about its standing up to its work were expressed, but it was decided that it should be tried, though not until the morrow, as night was falling and it would take some time to hoist it and get all its gear into working order.

By 10 p.m., the Eddystone light was nearly abeam with the Lizard light bearing by account, W. by N., about 42 miles distant. The course was now west, the wind having veered a point or so and, being very light, and the tide against us, we made very slow progress.

Daylight on Friday morning found us barely moving through the water, with the Lizard well forward of the beam. Two of the crew bathed and, after breakfast, the task of setting the repaired topmast was tackled in earnest. We went about on to the port tack, course N.N.W., the Lizard bearing W.N.W., and proceeded to hoist the topmast. By 11.45 the topmast was in position, shrouds shortened and the jib topsail was set. After that came the question

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of setting the jib header, and our skipper produced the bright idea of using the jackyard for the extra hoist necessary, due to the shortened topmast. The jib header was, therefore, lashed to the spar and, by 12.20 p.m., it was set as a club topsail, and it was unanimously agreed that it had never set so well.

By 2.30 the Lizard was abeam and we signalled to the station and learnt that *Nina* had passed the night before, and *Jolie Brise* and *Mohawk* that morning. As we could see *Lassie* well south of us and only slightly ahead, we were very pleased with ourselves. We learnt after the race that *Jolie Brise* was becalmed in Mounts Bay nearly all that day.

About 3 p.m., the wind fell right away and we were motionless, except for a slight fair tide, for nearly an hour during which time all the crew bathed. A light wind then sprang up enabling us to lay our course W.N.W:, a point free. As the breeze was very light, Hunt decided to test topmast still further by setting the yankee jib. This was done and the joints showed no signs of weakening, and, after setting the balloon staysail, we soon left the Lizard astern.

By 8 p.m., the wind was abeam; sheets were checked and the sheet leads of yankee jib and balloon staysail were boomed out, giving a much better set. At 9.30, Crone, our expert navigator, checked the compass by star azimuth, and found the deviation to be half-a-point west of the course, and at 11.45, when the Longships light opened, he fixed our position from the Lizard, Wolf and Longships.

At nightfall, the wind dropped and, later, a light breeze off the land, causing us to gybe, carried us slowly across Mounts Bay through a maze of lights, the Penzance fishing fleet at anchor, and shortly after one o'clock we were abeam of the Runnelstone.

Early on Saturday morning the wind veered to the S.E. and we gybed on to the port gybe and set the spinnaker. *Lassie* was about a mile away on our starboard bow and, though at first we went up on her, she went away later on in the morning. It was a glorious day with enough wind to keep us going well. The crew, feeling energetic, set the working staysail as a mizzen spinnaker, using the topsail yard as the boom. This was not considered a success, as *Lassie* appeared to leave us after it was set, and it was handed after much discussion.

At noon, our navigator fixed us and showed us further south than we expected. The course was therefore altered to N.W.$\frac{3}{4}$W.—our log read 41$\frac{1}{4}$. Two hours later the wind veered, spinnaker was handed, and the yankee jib and balloon staysail were once more boomed out.

By the end of one of the most glorious days imaginable, we were drifting through a calm sea about four miles astern of *Lassie*. The barometer, however, was falling fairly fast and more wind was

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prophesied. This prophecy was soon fulfilled, for the wind freshened considerably, and at 1 a.m. we had to hand the yankee jib for fear of our repaired topmast. No. 1 jib was set and with a beam wind and a smooth sea, we were soon going like a train. Just before daylight we ran into filthy weather and, though visibility for a time was very poor, we saw the starboard light of a boat passing us about a quarter-of-a-mile to leeward. She was going at a tremendous pace and we came to the conclusion after the race that she was *Neptune*.

At 5.10 a.m. the log read 141, showing that we had been doing eight knots since midnight. The skipper, our chief masthead hand, made a visit to the crosstrees and spotted the Gally Head light bearing N. by W., approximately distant twenty miles. This meant we were a bit far north and so course was altered to N.W. by W.

As day broke on Sunday morning, we found ourselves overtaking a yacht some distance ahead. Great was the discussion as to who she was—we hoped *Jolie Brise*. Our hopes were soon shattered, for as visibility improved, we discovered that she was *Lassie*. How *Lassie* was ahead of us we could not make out, as we were doing about two knots to her one, even after setting the working staysail instead of the balloon staysail which had carried away.

By breakfast time, the wind had lightened, the yankee jib was reset and *Lassie* was passed. Our navigator fixed our position from Cape Clear and Baltimore Bay and at 8.45 the Fastnet was sighted over the bowsprit. It was a cold, miserable day, and little could be seen of the mainland, as it was enveloped in fog. An hour-and-a-half later the wind died right away, and then, unfortunately for us, a light breeze sprang up from the N.W., giving us a dead beat to the Fastnet only a few miles distant. This beat took two precious hours, for we did not gybe round the rock until five minutes after midday, twenty minutes in front of *Lassie*. We learnt to our surprise that only *Nina*, *Mohawk* and *Jolie Brise* were ahead of us, making us still fourth in the running. (We learnt after the race that *Neptune* had passed during the previous night, but her identification signal had not been read and therefore not signalled to us by the light keeper.)

At 12.15, the spinnaker and yankee jib were set, log re-set, and the course set S.E. The weather by this time had much improved, and, with the sun shining and a following breeze, our spirits rose. The wind soon freshened considerably, and at 2.15 our second misfortune befell us. The spinnaker carried away at the clew, and even if repaired could only be used in light airs. The sail was got in with much difficulty and the first jib set on the end of the boom in its place.

By tea-time a strong N.N.W. wind was blowing, and the sea was decidedly rough. *Ilex*, always rather a difficult boat to steer in a following sea of any size, was giving the helmsman some heavy work,

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and, in fact, by the end of a spell of an hour and twenty minutes he was more or less exhausted. The log showed eight knots since 2 p.m., and we were going still faster. Between 6 and 9 p.m. the log registered just over ten knots, and it was probably registering slow as it spent half its time out of the water. By nightfall, the wind had eased off a little and the seas were much longer, making it much more comfortable. *Lassie* was well astern but further to the north, and though we were still doing about nine knots, she appeared to be making up on us a little.

At 1.30 on Monday morning, we saw a starboard light about three-quarters of a mile on our port beam. It turned out to be *Lassie*, as she signalled to us with a flash lamp. We answered with a Verey light to which she replied with a green rocket. An hour later, we saw a second starboard light directly ahead of *Lassie*. We hoped we had caught up *Jolie Brise*. We never discovered who this light was, as *Lassie* never saw any boats and, from what we learnt later, no other competitor could have been near at the time.

At 3.15 a.m. the Bishop Light, dead ahead, was picked up from the masthead, and Hunt decided to gybe. It was not a very pleasant task, as the night was very dark and there was still a strong wind and a big sea running, and, though the watch below was called up to assist, it was nearly an hour later before we were on our new course E. by S. After daybreak the wind backed, and we had to gybe again, an easy matter this time, as it was daylight and the sea had moderated somewhat.

At 8 a.m. the Cornish Coast was sighted over the port bow; by eleven, the Longships were abeam, and, after passing the Runnelstone half-an-hour later, a course of S.E.½E. was set to take us well clear of the Lizard on account of contrary tides. The weather had looked threatening the whole of the morning and just after midday we were struck by a heavy rain squall, which lasted nearly two hours. During the squall, we had to gybe and set a course E. by N. which carried us to Plymouth breakwater. Soon after 3 p.m., the rain stopped and the very unpleasant morning turned into a beautiful afternoon, which was spent in drying bedding and clothes, with the crew basking on deck. The wind eased off and the repaired spinnaker was set. This sail soon showed signs of going again at the clew, so it was strengthened by bunching it above the weak part and wrapping a stocking round the bunch. This held to the finishing-line.

At 8.30 p.m., the Eddystone was sighted on the starboard bow, and by 10 p.m. Plymouth breakwater was passed with *Lassie* well astern. We signalled our arrival in the Sound with two Verey lights, and after a tricky journey, trying to pick out the Channel buoy lights, we crossed the finishing-line at 10.28 p.m., *Lassie* finishing some twenty-odd minutes later. The run back from the

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Fastnet had taken 34 hours 15 minutes, probably the fastest time so far recorded in the Fastnet Cup Race.

We thought we had finished fourth, as we could not have saved our time on *Nina*, *Jolie Brise* or *Mohawk*, and *Lassie* was giving us two hours. It was not until the next morning that we learnt that *Neptune* had been ahead of us the whole race. We finished fifth, therefore, in the race of twelve starters. Had we not had the bad luck to break our topmast, we must have done very much better. We lost valuable time when the topmast went, for thirty-six hours we had to carry only plain sail, and for the remainder of the race the yankee jib and spinnaker had to be "tucked" to fit to the shortened topmast and the jackyarder could not be carried.

Three members of the crew, Hunt, Crone, and Francis, are to be congratulated on the results of the race. Hunt made an excellent skipper. He sailed *Ilex* as well as anyone could wish for, and, working like a navvy himself, he kept his crew up to scratch throughout the race. It was very largely due to his determination that a jury topmast should be rigged somehow or other, that it was not given up as a hopeless task.

Our navigator, Crone, amazed the crew with the accuracy of his fixes and by the variety of his methods. By shooting the sun or stars, he could tell us the correction of the compass and chronometer, and fix our position to the nearest mile with the greatest ease.

But for Francis, *Ilex* must have been out of the running altogether. His skill at jointing the topmast was worthy of a master carpenter. His task, which took the whole afternoon and evening, was made more difficult by the fact that *Ilex* was beating into a nasty choppy sea, but, so well was it done, the topmast not only lasted throughout the race, but it carried canvas till *Ilex* returned to Chatham.

Carter was well up to his usual high standard in providing hot meals and drinks whenever required, and made us very comfortable below decks. Without a doubt, this makes all the difference to a crew in a long race, and, though the weather was much kinder this year than in any previous Ocean Race, it was largely due to Carter's efforts that the crew were as fresh at the end of the race as at the beginning.

The result of the race, due to a large extent to bad luck, was not as good as was hoped for, and voices are already being raised against *Ilex* taking part again. They say we cannot hope to compete against boats like *Nina*, built solely for the purpose of ocean racing. We may not be able to beat her class, but the R.E.Y.C. has a high reputation amongst ocean racers and it would be a great pity if *Ilex* does not compete in the future.

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BATTLE HONOURS OF ROYAL ENGINEER UNITS.

(Continued from September, 1928, R.E. Journal).

JERICHO. 19TH TO 21ST FEBRUARY, 1918.

Unit.	Formation.		Remarks.
XX CORPS.			
436th (Welsh) Field Co.	53rd Div.	E.	
437th ,,	,,	N.E.	
439th (Cheshire) Field Co.	,,	D.	
519th (London) Field Co.	60th Div.	E.	
521st ,,	,,	,,	
522nd ,,	,,	,,	
1st Aust. Field Sqdrn.	Anzac Mtd. Div.	,,	
220th Army Troops Co.	XX Corps	N.E.	

SIGNALS.

JERICHO. 19TH TO 21ST FEBRUARY, 1918.

Unit.	Formation.		Remarks.
V Corps Signal Co.	XX Corps	E.	
53rd Div. Signal Co.	53rd Div.	,,	
60th ,,	60th Div.	,,	
1st Aust. Signal Sqdrn.	Anzac Mtd. Div.	,,	

JORDAN. 21ST TO 23RD MARCH, 1918. 11th APRIL, 1918.

Unit.	Formation.		Remarks.
XX CORPS.			
519th (London) Field Co.	60th Div.	E.	
521st ,,	,,	,,	
522nd ,,	,,	,,	
1st Aust. Field Sqdrn.	Anzac Mtd. Div.	,,	
No. 10 Field Troop	Imp. Camel Bde.	,,	
No. 13 Pontoon Park	G.H.Q.	D.	Attached 60th Div.
439th Field Co.	53rd Div.	,,	Attached 60th Div.

SIGNALS.

JORDAN. 21ST TO 23RD MARCH, 1918. 11TH APRIL, 1918.

Unit.	Formation.		Remarks.
60th Div. Signal Co.	60th Div.	E.	
1st Aust. Signal Sqdrn.	Anzac Mtd. Div.	,,	
Bde. Signal Sec.	Imp. Camel Bde.	,,	

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TEL ASUR. 8TH TO 12TH MARCH, 1918.

Unit.	Formation.	Remarks.
XX CORPS.		
65th Field Co.	10th Div.	E.
66th ,,	,,	,,
85th ,,	,,	,,
436th (Welsh) Field Co.	53rd Div.	,,
437th ,,	,,	,,
439th (Cheshire) Field Co.	,,	,,
519th (London) Field Co.	60th Div.	,,
521st ,,	,,	N.E.
522nd ,,	,,	,,
No. 5 Field Co. R.M.R.E.	74th Div.	E.
No. 5 Field Co. R.A.R.E.	,,	,,
XXI CORPS.		
484th (E. Ang.) Field Co.	54th Div.	,,
486th ,,	,,	,,
495th (Kent) Field Co.	75th Div.	,,
496th ,,	,,	,,
No. 10 Co. 2nd Q.V.O. S. and M.	,,	,,
ARMY TROOPS.		
14th Army Troops Co.	XXI Corps	N.E.
220th ,,	XX Corps	,,

SIGNALS.

TEL ASUR. 8TH TO 12TH MARCH, 1918.

Unit.	Formation.	Remarks.
V Corps Signal Co.	XX Corps	D.
10th Div. Signal Co.	10th Div.	E.
53rd ,,	53rd ,,	,,
60th ,,	60th ,,	N.E.
74th ,,	74th ,,	E.
U Corps Signal Co.	XXI Corps	,,
54th Div. Signal Co.	54th Div.	,,
75th ,,	75th ,,	,,

MEGIDDO. I.—SHARON. 19TH TO 25TH SEPTEMBER, 1918.
II.—NABLUS. ,, ,, ,, ,,

Unit.	Formation.	Remarks.
	I.—SHARON.	
XXI CORPS.		
484th (E. Ang.) Field Co.	54th Div.	E.
486th ,,	,,	,,
495th (Kent) Field Co.	,,	,,
496th ,,	75th Div.	,,
No. 10 Co. 2nd Q.V.O. S. and M.	,,	,,
No. 16 ,,	,,	,,
20th Co. 3rd S. and M.	3rd Indian Div.	,,
21st ,,	,,	,,
65th Field Co.	,,	,,
3rd Co. 1st K.G.O. S. & M.	7th Indian Div.	,,
4th ,,	,,	,,
522nd (London) Field Co.	,,	,,
1st Co. 1st K.G.O. S. & M.	60th Div.	,,
519th (London) Field Co.	,,	,,
521st ,,	,,	,,

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MEGIDDO I.—SHARON. 19TH TO 25TH SEPTEMBER, 1918.
II.—NABLUS. " " " "

Unit.	Formation.	Remarks.
	I.—SHARON.	
DESERT MOUNTED CORPS.		
4th Field Sqdrn. (late 6th)	4th Cav. Div.	"
5th " (late 7th)	5th "	"
2nd Aust. Field Sqdrn.	Aust. Mtd. Div.	"
ARMY TROOPS.		
14th Army Troops Co.	XXI Corps	"
13th Pontoon Park	"	"
	II.—NABLUS.	
XX CORPS.		
18th Co. 3rd S. and M.	10th Div.	E.
66th Field Co.	"	"
85th "	"	"
436th (Welsh) Field Co.	53rd Div.	"
437th "	"	"
72nd Co. 3rd S. and M.	"	"
CHAYTOR'S FORCE.		
1st Aust. Field Sqdrn.	Anzac Mtd. Div.	"
ARMY TROOPS.		
220th Army Troops Co.	XX Corps	"

PROFESSIONAL NOTES.

MILITARY ENGINEERING, VOL. III, 1928.

A NEW edition of *M.E. Vol. III* has recently been published, and the following notes indicating the main differences between the new and old editions may be of interest.

Various amendments and additions to the new edition have already become necessary, and are being taken up; they have not been specifically dealt with in these notes.

GENERAL ARRANGEMENT.

Instructions on Pontooning are now contained in a separate pamphlet, " Pontoon Bridging, 1928," and the chapter on pontooning has therefore been omitted.

The majority of the tables have been collected together at the end of the subject matter and just before the plates. This should facilitate reference to them.

The chapters on Inglis, Hopkins, and other stock span bridges, have been omitted, as these types are no longer retained as R.E. Vocab.

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Stores. Plans and details of construction are being preserved in case any of them should be required on some future occasion.

A chapter on the Box Girder Bridge is included.

The Text.

Chapter I has been re-written.

Sec. 2 gives the classification of military equipment bridges, and should be read in conjunction with Sec. 14.

It should be noted that the classification in Section 2 refers to bridges carried by formations as part of their equipment. The classification adopted for other types of bridges, as given in Section 14, was found necessary, as the definition of heavy bridge as applied to equipment bridges was unduly wide.

The question of bringing these two classifications more closely into agreement will require further consideration as soon as the loads to be carried become more stabilized.

The statement in Section 2, para. (iii), that the heavy equipment (pontoon) bridge will carry 16-ton axle loads, assumes that a very small proportion of the weight on the adjoining axle will be taken by the pier carrying the 16-ton axle load at any moment.

Chapter II has been re-written and condensed. It deals more fully with the subject of reconnaissance, and omits most of the detailed instructions on the framing of reports. This is in accordance with the principle that an engineering report is only a particular form of appreciation, and should, therefore, follow the same general lines as any other appreciation, as indicated in *T. and M. Regulations*. Details must naturally vary considerably with the circumstances, and no hard and fast rule can be laid down as to what should or should not be included. Further details of work tables, transport tables, etc., are given in Chap. IX, Sec. 57, Organization of Work.

Sec. 11 contains, more appropriately, the details of fords and the crossings which used to be in Chapter I of the old volume.

Chapter III has been considerably expanded.

Sec. 12 is new, and deals with the elementary theory of bridge design.

Sec. 13, bridge loads, lays down clearly what allowances should be made for impact. These differ considerably from the old impact factors, and it should be noted that no impact allowance is necessary for track vehicles or for infantry, when the figures for "crowded at a check" are used.

Sec. 14, table of loads, is a further elaboration of Sec. 2. It should be noted that all heavy loads are only allowed to cross a bridge singly. A load may, however, consist of a train of artillery vehicles, and for any span of more than 30 feet or so, the artillery train usually causes

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worse cases of loading than a tank. The actual loads due to animals and vehicles are given in Tables A to E.

Sec. 15 has been added, and deals with the effect of track vehicles on bridges.

Sec. 16, ruling dimensions. A 9-ft. roadway is now given as the normal width for all ordinary M.T. vehicles, whereas on p. 37 it is stated that the roadway for M.T. should be 10 ft. wide. By having a 9-ft. roadway it may be possible to economize in the number of road-bearers and size of decking. Apart from this, there is no object in cutting down the roadway to less than 10 feet. There are also a few other minor alterations, such as 1-ft. 10-in. and 5-ft. minima for infantry in single file and file respectively.

Sec. 17, working stresses, is much the same, but the table giving the working stresses in timber also includes the weight.

Sec. 18 now contains a sub-paragraph on shear, though still perhaps in too little detail, as it does not touch on the relation between the average and maximum intensities. Sec. 46 and 47 in Chap. VII work out in full two typical examples of the normal calculations necessary to make clear the practical application of the theory of shear. Sec. 47, however, contains one or two errors.

Sec. 19 has been added, and deals with the design of road-bearers and decking. This section, together with Table H, to which it refers, should prove useful.

Sec. 20 is also new, and deals with the carrying capacity of existing bridges, which has not been dealt with previously.

Chapter IV contains everything in the old Chaps. IV and V that is not now included in "Pontoon Bridging, 1928." It contains sections on buoyancy, rafts, flying bridges, anchors, tidal ramps, piers and pierheads. All these sections have been largely re-written and increased in scope.

The table in Sec. 21, giving the details of boats used in the Royal Navy, contains many alterations.

Sec. 24, Flying Bridges, includes methods of getting a line across a river.

Chapter V corresponds to the old Chap. VI, and contains only a few minor alterations.

Sec. 29 includes a new method of reeving tackles which allows the pull to come off the centre sheave without any crossing of returns. This method tends to prevent twisting and also reduces the friction, but, of course, is of more value for heavy and light gyn tackles than for tackles that do not contain a treble block. It does not, however, seem to decrease the tendency to twist in long runner tackles, and certainly does not do away with the necessity for anti-twisters.

At the end of the chapter there is a useful summary of formulæ used in designing derricks and tackles.

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Chapter VI corresponds to the old Chap. VII, and contains only a few minor alterations. The section on aerial ropeways has, however, been omitted.

Sec. 31 contains an improved method of making up a cable.

The examples in Secs. 33 and 36 have been corrected.

Chapter VII. The old Chap. VIII, has been almost completely re-written.

Sec. 39 contains only minor alterations, including the advantages and disadvantages of the use of "dogs."

Secs. 40 to 43 deal more fully with the design and construction of trestles.

Sec. 44 on timber cribs has been added as a separate section.

Secs. 46 and 47 have been added, and contain fully worked out examples of the use of single trestles and a trestle pier. Sec. 47 contains one or two errors. The amendment of these is being taken up.

Sec. 48 on timber girder bridges has been enlarged, and deals more fully with the joints and calculations.

Chapter VIII. The old Chap. IX, has been completely re-written.

Sec. 50 deals more fully with the design of footings, and also contains a sub-paragraph on the effect of scour.

Sec. 52 includes calculations for bearing power of piles, and only gives Wellington's formula, omitting the modification of Trautwine's formula that used to be included. It should be noted that the formula now given differs from that in the old volume, as the factor of safety now allowed is 4 instead of 6. A short table showing safe loads is given at the end of this section.

Sec. 53 includes details of a portable pile-driver suitable for use in the field.

Sec. 56 has been added and gives details of an example of a rapidly constructed pile bridge.

Chapter IX is much the same as the old Chap. X, but some of the paragraphs have been condensed. The table giving the dimensions of transport includes the details of six-wheelers.

Chapter X gives full details of the box-girder bridge. It must be realized, however, that there are sure to be many alterations as improvements are suggested. The design of the actual roadway will probably be altered so as to allow a greater clearance between the curb and the handrails. The method of launching is also undergoing change. The two-derrick method is obsolescent. To avoid the use of the second derrick or jacks to lower the girder off the rollers, a spar can be inserted under the end of the girder, and the girder levered into position.

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The following are some of the minor points which require consideration :—

1. The removal of the projecting corner of the plate riveted to the hornbeam at the lower end of the sloping portion.
2. The provision of rollers of sufficient width to take the full width of the hornbeam section.
3. The revision of the number and size of small stores, such as strops, shackles, etc.

It must be remembered that the stores provided are for normal launching conditions, and that calculations must be made for any conditions that are abnormal, both as regards strength and length of ropes required. For example, when building a bridge of two spans, an 80-ft. and a 30-ft., if the derrick has to be placed at the far side of the 30-ft. span in order to haul the box-girder across the 80-ft. span, the stress in the preventer tackle is increased to about 10 tons. Other similar instances may easily occur. Perhaps, also, it is not brought out sufficiently clearly that a considerable quantity of stores has to be taken across the gap before the box-girder itself can be launched. If the bridge is to be built rapidly, good organization and attention to such minor details are essential.

TABLES.

General remarks. As already stated, most of these tables are grouped together at the end of the text, but it might be well to summarize here the few small tables which do appear in the text itself, as these are not indexed anywhere.

Weight of infantry, cavalry, etc.	p. 29
Load classification	p. 30
Ruling dimensions	p. 31
Working stresses	p. 33, 34
Dimensions of boats	p. 43
Dimensions of barrels	p. 44
Stores for a barrel pier raft	p. 45
Deck spaces required by men, horses, etc.	p. 48
Safe pull in anchors	p. 54
Summary of formulæ for tackles, etc.	p. 92
Tensions in suspension bridge members	p. 102
Length of slings for suspension bridges	p. 103
Holding power of buried anchorages	p. 120
Safe load on trestle legs	p. 131
Safe load on piles	p. 158
Loads that can be carried on lorries	p. 169

Many very useful tables have been added, most of them in the form of ready reckoners, designed to save time and energy that would

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otherwise have to be spent on lengthy calculations, as will be seen from the following detailed notes.

Tables A to E. Bridge Loads.

Six-wheelers have been included, but unfortunately tanks, including some of the obsolete type, are still shown under their old nomenclature. It should be noted that the axle weights of a 3-ton lorry are slightly larger than those shown in the old Vol. III. Wheel track dimensions, unless otherwise stated, are centre to centre.

Table F. Equivalent uniformly distributed dead loads.

Is an up-to-date edition of the old Table G.

Table G. R.S.J.s.

Contains the properties of the British new standard joists.

Table H. Size of decking and roadbearers.

This has also been added. It is valuable, as considered in conjunction with Sec. 19, it is the only quick method of arriving at the distribution of the load to the roadbearers and of assessing a suitable size of decking.

Table I. Bending Moments and Shear.

This does away with the need for many calculations that would otherwise be necessary. For any class of loading, this table shows at once the maximum bending moments set up, the maximum end reaction, and therefore the maximum shear. Spans of from 10 to 150 ft., at 5 ft. intervals, are given for medium loads, and all three classes of heavy loads. It should be noted that all necessary allowance has been made for live loads, but that consideration must be given to uneven distribution to the several roadbearers, and allowance made for the weight of the superstructure.

Table K. Arches.

Gives the necessary crown thickness of arches in two cases, *i.e.*, 10-ton and 16-ton axle loads. This is a very valuable addition.

Tables L and M.

Are much the same as the old Tables O and P on the strength of cordage and steel wire ropes.

Table N. Iron Wire.

Has been added and gives all details, including size, weight, and strength.

Table O. Strength of ropes and tackles.

Is another valuable ready reckoner and saves the use of the formula $P = \frac{W}{G}(1+fn)$ in all cases (with $f = 1/10$), and also gives the pull in slings of tackles.

Table P. Timber girder bridges.

Is an improvement and enlargement on the old Table S.

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Table Q. Work Table.

Differs considerably from the old Table T, and is worth study.

Tables R, S, T.

Are practically the same as the old Tables U, V, W, specimens of transport and stores tables and of a progress record.

Table U. Man-hours for various jobs.

Is an up-to-date edition of the old Table X.

Tables V, W, X, Y, Z. The box girder.

These are all new. One error in Table XX should be noted. The two treble blocks should be used in the preventer tackle and one treble and one double block in the hauling tackle. This error also occurs in the corresponding Plate 73. As mentioned above, it is quite probable that several minor alterations will be made in the tables of stores.

The Index has been enlarged, and reference can now be far more readily made to the text. The text itself refers to all tables and plates.

PLATES.

The total number of plates has been reduced by nearly half. Those that have been omitted deal chiefly with the old stock spans, pontoon equipment, aerial ropeways, etc.

The following plates need, perhaps, special mention :—

Plate 2. *Tanks.*

Is unfortunately not up-to-date, but amendment has been taken up.

Plate 3. *Graphical determination of* M_r.

Has been extracted from the old Vol. IIIa, and is most useful. It is the only place in the book where any data as to the strength of rails can be found.

Plates 10 *and* 11 are new, and show methods of getting a line across a river.

Plate 32. *Making wire ropes.* Has been added.

Plate 47 is an example of the amount of detail required in a working drawing.

Plates 50 *and* 51. *Timber trusses.*

Are a great improvement on the old plates, and show the method of construction far more clearly.

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BOOKS.

OFFICIAL HISTORY OF THE WAR. MILITARY OPERATIONS, FRANCE AND BELGIUM, 1915.

BATTLES OF AUBERS RIDGE, FESTUBERT, AND LOOS.

Compiled by BRIGADIER-GENERAL SIR JAMES E. EDMONDS, C.B., C.M.G., R.E. (retired), *p.s.c.* Maps (in separate case) and Sketches compiled by MAJOR A. F. BECKE, R.A. (retired), HON.M.A. (Oxon). (MacMillan & Co., Ltd., London, 1928. Price 12s. 6d., Maps 5s. 6d.)

In his preface Sir James Edmonds reminds his readers that the historian is forced to depict a battle with an orderliness which was not apparent during the actual events, and that it is quite impossible to give an adequate representation of the organized confusion of modern warfare. If the power to obtain orderliness out of chaos is a fault, the official historian is to be congratulated on possessing it. For, whether the reader scans the volume in an armchair over the fire, or whether he sets out to make a detailed study of the operations with Major Becke's excellent maps spread before him, he cannot but admit that the narrative of each battle is wonderfully easy to follow. The account of the Battle of Loos especially is a masterpiece of clear expression, orderly arrangement and valuable criticism.

The mistakes that were made in these first offensives of the B.E.F. are clearly indicated, and, where necessary, commented on. The lessons they teach cannot fail to impress themselves on the mind of the reader, whether he be an experienced soldier or a youngster with his baptism of fire still before him.

General Edmonds was fortunate in being able to submit the typescript of this volume to the late Field-Marshal Earl Haig. The Commander of the First Army of 1915 not only made marginal notes on the draft, but also wrote some general remarks on the various chapters. The accuracy of the narrative and the correctness of General Edmonds' appreciation of the condition of affairs during the period covered by the volume are thus hall-marked by the highest authority, after a sufficient lapse of time to allow of events being seen in true perspective.

It will be remembered that the general plan of operations of the Allies for 1915 was based on the knowledge that, after carrying on operations against the Russians throughout the winter, the Central Powers were preparing a great offensive on the Eastern Front, and to strengthen it had withdrawn a large number of troops from the West. The movement of these reserves—amounting to 100,000 men, with a full complement of artillery—offered the Allies a great opportunity not only to assist Russia,

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but also to drive the invader out of France and Belgium. Moreover, a speedy offensive would be in keeping with sound strategy.

At this crisis there was no divergence of opinion between the Allied Commanders-in-Chief, or the Allied Governments, as to the necessity of assuming the offensive as early as possible in the spring. As the preparations progressed it became evident that the Germans were working at their defences, but Sir John French probably had little conception of what was really going on behind the German wire, and, if he had suspicions, he had no gun ammunition to spare for " strafing " the German working parties at night.

The German Higher Command were fully aware of the risks they were taking on the Western Front by the withdrawal of reserves. The Battle of Neuve Chapelle had exposed the weakness of their front line defences, and, immediately this battle ended, they set themselves systematically to strengthen the line. An immense amount of work was accomplished, strengthening breastworks, parapets, and wire, and constructing dug-outs, hidden machine-gun emplacements, and support and communication trenches. The fact of the completion of so much work in so short a time—eight weeks—is made the subject of special mention in the histories of some of the German regiments concerned. The result of their efforts was that, when the Allies were ready to attack at Vimy and the Aubers Ridge in May, they had a very different proposition to face to that which had confronted the British at Neuve Chapelle in March, when the German front was all but pierced.

The Allied offensive was launched on 9th May. The French Tenth Army, under General d'Urbal, after a bombardment lasting six days, achieved considerable initial success in their attack on Vimy Ridge. But the British, who had only enough ammunition for a short preliminary bombardment of 40 minutes in the early morning of the 9th May, failed to break the line at Aubers Ridge, fifteen miles north of the French. Although the British attack came more or less as a surprise, it was not altogether unexpected by the Germans. By the evening of the 9th of May, the German Higher Command were satisfied that the local troops could hold the British, and were able actually to set in motion what reserves they had—two divisions—and divert them to assist in the defence of the Vimy Ridge position.

Little is said about the British attack in the German histories. They recognize that it was undertaken to assist the main, the French attack.

It is interesting to note that, after the move of the two German divisions in reserve to Vimy, there were no reserves whatever behind the German line between Armentières and the La Bassée Canal.

The Official Historian's comments on the Battle of Aubers Ridge are as follows :—

" The results of the offensive of the 9th May were a serious disappoint-
" ment. . . . Their (the Germans') industry in improving their defences
" had been fully repaid : it was one more example of the truth of the
" German Army proverb that ' sweat saves blood.' A British infantry
" brigadier summed up the matter, at the close of the battle, in the words,
" ' the sapper has beaten the gunner.' *The Times* newspaper, in a
" leading article on 14th May, said, ' British soldiers died in vain on the

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" ' Aubers Ridge, on Sunday, because more shells were needed.' Neither " phrase entirely fitted the situation. The failure at Aubers Ridge was " in fact due to three causes : first, the strength of the German defences " and the clever concealment of machine-guns in them ; secondly the " lack on the British side of sufficient shells of large calibre to deal with " such defences ; and thirdly, the inferior quality of much of the ammuni- " tion supplied and the difficulties of ranging, so that the British gunners " were unable to hit their targets and the German counter-batteries and " machine-guns were not silenced." Defective fuzes : shells that did not burst : worn guns causing shells to fall short. As a general result, the brief 40-minutes bombardment, though it raised a curtain of dust and smoke immediately above the enemy's front line, did no appreciable damage, and merely gave the enemy warning to stand-to to meet an assault which he had been expecting for twenty-four hours before it was delivered.

On the 15th May, General Foch decided to renew his efforts against the Vimy position ; and, although the desperate situation of the Second Army at Ypres, where the Battle of Frezenberg Ridge (8th–18th May) was in progress, caused Sir John French the gravest anxiety, the British C.-in-C. had no thought of abandoning his offensive operations in support of the French Tenth Army.

Events in other theatres—the failure at Krithia (6th–8th May), and the successes of the Austro-Germans in Galicia—had far-reaching effects, and Sir John French was kept in doubt as to what reinforcements, if any, he would receive from England before he resumed the offensive. Preparations were, however, pushed on for a second effort north of Festubert. Sir Douglas Haig decided to depart definitely from the procedure of previous British attacks. He now proposed to follow the French method of a long methodical bombardment of the enemy defences before the infantry were sent forward. This bombardment commenced on 13th May, and was continued on the 14th May. On the 15th May, there were during the day two short intensive bombardments in the nature of feints in the hope of inducing the enemy to man his parapets, but the main assault was not delivered till 11.30 p.m., and then without any preliminary bombardment, by the 6th, 5th, and Garhwal Brigades. The right of the 2nd Division attack was entirely successful in capturing its limited objective, the German front line defences, but the centre and left attacks failed to reach the enemy's front trench—the element of surprise having being unwittingly eliminated by feints further to the left, which had put the enemy on the alert.

At 3.15 a.m. on 16th May, the 7th Division attacked with two brigades after an intensified bombardment lasting half an hour, and was partially successful. But a gap was left between the breaches made by the two divisions. The Germans endeavoured to re-establish their front line, but failed to do so, and after working desperately to improvise a new front line in rear, they withdrew to it on the evening of 17th May.

From this new position they were never ousted, despite repeated attempts by brigades, including the 4th Guards Brigade, of the 7th Meerut, 2nd Canadian and 47th Divisions. The fighting continued until 25th May, when the battle was allowed to die down.

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The remarks of the Official Historian on the Battle of Festubert must be quoted :—

"The results of the attack at Festubert had been tantalizing. Undertaken solely for the purpose of assisting the French, considerable success had been achieved even with the small number of guns and limited amount of ammunition available. . . . The Germans had been compelled to withdraw from a strong position on which they had expended many months of labour to a hastily improvised new line. If this new line could have been attacked at once, there was every reason to expect that it could have been easily carried. How perilous the enemy thought the situation on the 16th and 17th May owing to the dearth of reserves will be seen from his narrative in the Note (pp. 80–81–82) at the end of this chapter. The British leaders felt that they were on right lines, and that with more gun support they might have reached Aubers Ridge . . . success was judged to be a matter of persistence. Another similar effort might break through the German line and at any rate compel the enemy to bring up greater reinforcements, which otherwise might be used against the French, who had made good progress. The fighting standard of the Army . . . was now improving again. . . . On the material side, however, heavy guns and high explosive shell were . . . not yet forthcoming. Yet every day's delay in providing them meant another twenty-four hours presented to the enemy in which to perfect his defensive arrangements and increase the difficulties of the next attack. For the moment, the Germans seemed to be superior in both attack and defence . . . but it was thanks only to their overwhelming superiority in artillery, trench mortars, and machine-guns, and the greater effectiveness of their stick grenades. At the close of the battle, the British Commanders not unnaturally felt that, given anything like the same equipment for close fighting that the enemy battalions possessed, their infantry, even with its hastily trained subordinate leaders, could be relied on in the attack to do better than the foe."

It can be deduced from the above that the Official Historian is of opinion that the British C.-in-C. was justified in fighting at Festubert until his divisions were exhausted, even after the failure at the Aubers Ridge, on the ground that the opportunity for an offensive to expel the invaders of France and Belgium, afforded by the absence of so many German divisions in Russia, might never recur, if for no other reason.

Field-Marshal Earl Haig's comments on the accounts of the two battles are as follows. Of the Aubers Ridge chapters he wrote :—"I think you have brought out very well the terrible conditions under which the First Army had to carry out the C.-in-C.'s orders to support the French at all costs. The ammunition was very bad: fuzes inefficient; and a great shortage of all kinds of shell. So that the means for a real bombardment were lacking." His remarks on the Festubert chapters were :—"A very true account of the situation of the B.E.F. in the summer of 1915. You show very well what tremendous efforts and what sacrifices all ranks made to support fully and loyally our French Ally. And I hope that the British people will realize

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" what ' unpreparedness for war ' cost the Empire in flesh and blood in " the years with which you are dealing."

The French offensive launched simultaneously with the attack at Festubert was also unsuccessful. In a note on the operations of the Tenth French Army between 15th May and 18th June against the Labyrinthe, Neuville St. Vaast and Souchez, General Edmonds quotes the French special reports for the reasons for the lack of success :— " The insufficient number of heavy guns and the domination of the " German heavy artillery : the numerous burstings of guns, and the " defective gun ammunition, owing to hasty manufacture : the want of " experience of officers and N.C.O.s owing to previous heavy losses." He also quotes the French Official History :—" Our battalions often only " pushed on straight ahead, bravely, but without thinking of manœuv- " ring, and they often lost by enemy counter-attack ground that they " had brilliantly won."

The German losses in this period—50,000—were less than half the French—104,000.

The only fighting in the interval between the Battles of Festubert and Loos took place on June 15th–16th at Givenchy, south of Festubert ; on June 16th at Bellewarde Ridge : and on July 30th at Hooge. The British attack at Givenchy failed owing to lack of covering fire in the initial stage, and the only ground won was lost again owing to the persistency and efficiency of the German bombers.

The attempt to improve the 2nd Army front facing Bellewarde Ridge (north of Ypres) was entrusted to the 3rd Division. " Reliance was placed," writes Gen. Edmonds, " on surprise as to time rather than " deception as to the place of attack. Unfortunately the German " observation posts on Bellewarde Ridge were too far away to be taken " in the first rush ; they commanded all the ground over which the " advance was made, and so long as the Germans held them they directed " converging fire over it."

Though the re-entrant in the British front had been slightly reduced and the British line carried forward to just north of the Menin Road, the enemy retained possession of the Bellewarde Ridge and the observation posts on it. The losses—140 officers and 3,391 other ranks—were almost entirely due to the enemy's artillery fire, with which the British heavies, handicapped by inadequate guns and limited ammunition, were unable to cope. The Germans lost 157 prisoners, but only suffered about 300 casualties.

The enemy attack on the trenches of the 8th Rifle Brigade (14th Division) at Hooge at 3.15 a.m. on 30th July was a complete surprise, and would probably have led to an entry even at the strongest point of the line. It was the first attack on the British with *Flammenwerfer* (liquid fire throwers), and was supported by an overwhelming artillery and trench mortar bombardment.

In these early days, it was an unwritten law that if trenches were lost they must be immediately regained. The counter-attack, a frontal one across open ground, was launched at 2.45 p.m., and resulted in three battalions of the 43rd Brigade (14th Division) being practically wiped out. The only possible chance of success was to have deferred it till the

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evening or night. A new line was consolidated through the northern edge of Sanctuary Wood and along the north-east edge of Zouave Wood. This was attacked by the Germans at 2 a.m. on the 31st July, again assisted by liquid fire, but they failed. The efforts of the 14th Division to gain ground on the 31st were brought to nought by the enemy's heavy artillery fire. "It was then clear," writes General Edmonds, "that "nothing but a regular attack, thoroughly prepared—as distinguished "from a hasty counter-attack—would dislodge the enemy. . . . The "attack (carried out by General Congreve's 6th Division) was a model of "its kind, took the enemy by surprise, and was entirely successful; "it marks further progress in the methods of minor operations." It is fully described on pp. 106–109, and should be studied.

THE BATTLE OF LOOS.

Despite the ill-success attending the Allied offensives in May, General Joffre and Sir John French were in absolute accord as to the necessity of continuing the offensive in accordance with the original French plan for the 1915 campaign. This was to advance on two convergent lines, by attacking in Champagne northwards, and in Artois eastwards, so as to pinch the three German armies holding the great German salient about Noyon and get astride their lines of supply and retreat, and so drive the invaders out of France and Belgium. It was originally intended to make a third advance from the Verdun-Nancy sector, but this it was now decided to defer.

But the effect in England of the great losses incurred by the B.E.F. in March and May, coupled with the want of success in Gallipoli, and the failure of the Italian offensive, had brought another factor into the problem. Mr. Lloyd George had now become Minister of Munitions, and in that capacity he represented the British Government at a series of conferences held at Boulogne on the 19th and 20th June, which was attended by the French Minister of Munitions and representatives of the British and French Headquarters. The result of these conferences was a decision by the British Military Authorities that, in view of (1) the shortage of guns; (2) the shortage of gun ammunition; and (3) the fact that the spring offensives had failed—largely because of the lack of both infantry and artillery—owing to the attacks being delivered on too narrow a frontage, a British offensive on the Western Front, if it was to have reasonable chances of success, would have to be delivered on a continuous front of at least 25 miles, by a force of not less than 36 Divisions, supported by 1,150 heavy guns and howitzers and the normal complement of field artillery. It was further maintained by the Minister of Munitions that as this quantity of guns and the necessary ammunition could not be forthcoming before the spring of 1916, until then it was preferable, whatever the general situation, to remain on the active defensive in the western theatre of war. This expression of opinion in no way affected the determination of General Joffre to go on with the French plan for an offensive at as early a date as possible; and there is no doubt he had public opinion in France behind him.

Thus a vital difference of opinion now arose between French and

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British Headquarters in France. General Edmonds describes the progress of negotiations, of which the first outcome was that it was arranged that the offensive must be postponed to the end of August to allow time for the relief of the French XIth and XIVth Corps by the newly-formed British Third Army—south of the French Tenth Army—and further necessary preparations.

During these discussions it became evident that, owing to the continued success of the renewed German offensive in the East, it was not unlikely that the Russians would drop out of the war before the end of the year unless the Allies could compel the Germans to relax their pressure on the Eastern Front. So it came about that, against the judgment of Sir John French, the participation of the B.E.F. in the proposed French offensive was eventually ordered by Lord Kitchener.

The next difficulty was to decide on which sector the British should attack. The French insisted that the British attack must be close to the left of the French Tenth Army, that is, south of the La Bassée Canal. Sir John French favoured an attack astride the Canal, together with an attack on the Messines Ridge, to relieve the situation in the Ypres Salient. Sir Douglas Haig wished to attack only at the Aubers Ridge. Eventually Sir John had to yield to French pressure, and it was decided to attack at Loos in conjunction with the French Tenth Army on the British right. Subsidiary attacks were to be made simultaneously by the III Corps at Bois Grenier, and by the V Corps at Bellewarde Ridge. Precious time had already been lost.

Further delay was caused by the backward state of the French preparations in Champagne, which was now to be regarded as the most important attack. Eventually, on Sept. 4th, it was decided to start the offensive on Sept. 25th. As events have proved, the respite of two months thus given to the enemy was fatal to the Allies.

" In war," writes General Edmonds, " delay is generally more advant-
" ageous to the defence than to the attack ; so now, while the French
" and British were accumulating their heavy guns and ammunition, the
" Germans were even more diligent in strengthening their defences.
" They realized no less clearly than the Allies that, with an increased
" supply of heavy artillery and a greater volume of ammunition, French
" and British attacks like those in May and June, 1915, might well break
" their present system of defence on the Western Front. In all haste,
" therefore, they set about finding appropriate counter-measures.
" Ignoring the precept of their peace-time manuals—one line of defence
" only and all efforts devoted to it—the plan adopted was to build a
" second defensive system from two to four miles in rear of the first,
" and of similar, if not greater, strength."

By the end of July, the second position had assumed a definite form on the whole length of the Western Front, and, where the line itself was not complete, strong points and redoubts containing emplacements for machine-guns had been prepared every few thousand yards.

The existence of this new system of defence, which was clearly visible on air photographs, altered the aspect of the attack, and clinched matters as regards the object and objectives of the British offensive.

The reader must go to the Official History for the narrative of the

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battle, for it can hardly be further condensed. The orders for the assault were complicated by the use of gas, now available for the B.E.F. for the first time. Every eventuality seems to have been provided for should the wind prove unfavourable. In the event, it was only partially favourable. Had the wind been wholly favourable there is little doubt that the initial attack would have been successful on the whole front. Whether a break-through would have been achieved it is impossible to say, for mistakes were made which might have prevented the reserves being up in time to carry the operation to its final objective. To understand these mistakes we cannot do better than quote from General Edmonds' " Retrospect " :—

" It would be idle to pretend that the outcome of the Battle of Loos " was not a bitter disappointment ; the more so as such decisive results " had been expected from the attack of the French Tenth Army, to " facilitate which the battle was undertaken and fought. . . . The plan " devised by General Haig . . . was a sound one. It was known that " the Germans had no large reserves at hand, and it was fair to assume " that the great French effort in Champagne, and the lesser one on the " immediate right near Souchez, would draw off a considerable portion, " if not all, of the small numbers available. The First Army and its " Corps had not kept back reserves, but had used all their forces in the " front line ; for everyone understood that the XI Corps constituted the " reserve that would push through, or at least would be sent up by " divisions as soon as the reserve brigades of the assaulting divisions had " been put in. The head of the XI Corps might have been up by 6.30 " a.m. (the hour of the original assault), well fed, its route reconnoitred " and cleared. At 10.30 a.m. the two leading divisions of the Corps " were still in their bivouacs between Noeux les Mines and Beuvry. By " that time it was already too late ; the critical moment had passed, the " momentum had been lost, and though it was still possible to gain a " minor success, the big opportunity had gone for ever."

" The attempt of Sir John French to influence the battle by holding " back divisions in reserve was ill-considered and tactically out of date ; " he had not even had routes specially marked and kept clear, so that " the General Reserve could be rushed up at the utmost speed. War- " experienced divisions would no doubt have managed to get up to the " front more quickly than did the two newly-arrived ones chosen by the " C.-in-C., and would have reached the field comparatively fresh and well " fed ; but to hold back a reserve composed of such raw troops was " fatal."

" Time was the issue of the matter. . . . Everything depended upon " whether the British general reserve or the German units to stem the " flood arrived first. And the former might have been ready and " prepared to move at the shortest notice to the place where the German " line was most likely to break, while the enemy was bound to wait and " see where his scanty reserves were most required. On the one side " there was a clear-cut issue ; on the other, doubt and the doubtful " problem which usually confronts the defender."

" The 21st and 24th Divisions, which, together with the Guards " Division, formed the General Reserve, were imperfectly trained, had

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" never been in line, far less in battle, and did not know the ground, but " given the opportunity which had been offered with the German " infantry on the run and guns limbering up and going, they were " probably adequate to take a certain advantage of it. Indeed, the " C.-in-C. selected these divisions because he shared the opinions expressed " at the time by some officers who had been in the Ypres Salient, that " Divisions long engaged in trench warfare had got out of the way of " attacking and manœuvring in the open, and that therefore it was " better to employ untried ones. The Guards Division he regarded as " a final reserve. He meant to engage the others, but his lack of faith " in divisions wholly made up of new troops continued to influence him, " and in the end he procrastinated while the First Army, its corps, and " its divisions had relied on prompt action." For although it was certain that Sir John French had been committed to an offensive against his better judgment, all assumed that, having definite orders to attack with vigour, he meant to do his utmost. Whether three divisions, the Guards leading, would have been enough to deal with the German reserves, including the Guard Corps then in hand, can never be known.

" If the Guard Corps (two divisions) had been put in against the " British front, it would not, as it was, have been diverted to the Vimy " front, and the French might have broken through and restored the " battle. Once battle was engaged, the risk of meeting enemy reserves " had to be taken ; the original assaulting divisions could at any rate " have consolidated their gains, as the 24th Division did near Loos " Crassier, the 15th Division on Hill 70, and the Loos-Hulluck road, and " the 7th Division on the line of Gun Trench, whether the XI Corps came " or not."

" The French, with their greater forces, many more guns, and vast " ammunition supply, as compared with the British, equally failed to " break through, but for other reasons. There was no surprise. In " Champagne, the enemy did not attempt to hold them in his first " position, but met them, with every advantage, in his second ; in " Artois, the front line on Vimy Ridge was of great strength, having been " attacked before, and it was entered only at a few places. The French " official explanation of the failure is first, that the infantry were not " fully prepared owing to certain divisions arriving on the ground only " shortly before the attack, and others having their tasks and zones of " action modified ; secondly, owing to bad weather the artillery prepara- " tion so lacked precision and certainty that a postponement of the " attack was advisable, but the state of ammunition supply did not per- " mit of this : thirdly, the enemy wire was not efficiently destroyed ; " fourthly, and this is of particular interest, some of the Army Reserves " were too close up to the front. As there was no break-through, there " was no opportunity to employ them, and being in the battle zone, they " suffered heavy losses for no purpose ; further, being so near the front, " the area in which they could be used was limited, and they were not " available to be directed where they were most particularly required. " Sir John French did not make this mistake. But he not only placed " his reserve divisions too far back, but the steps which might have been

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" taken to keep the way clear for their advance when it was ordered were " not taken."

General Edmonds is only just in correcting the hasty and wrong impression which prevailed in some quarters after the battle as to the conduct of the new divisions. " All knew "—he writes—" that as a whole the new divisions had done magnificently, and would do better next time in spite of the heavy gaps in their ranks." This judgment the writer can warmly endorse, for the 63rd Brigade, then in the 21st Division served under his command for over two years, and all its battalions, in particular the 8th Somerset Light Infantry, whose gallantry at Loos is mentioned, and which bears more battle honours than any battalion of that famous regiment, never failed to make good in attack, while in defence they more than justified the reputation of the English county regiments for the tenacity with which under the worst conditions they held on to the ground they had won.

The 1915 volume concludes with a note on the inception of the Salonika Expedition and the evacuation of the Gallipoli Peninsula, and a reference to the transference of the Indian Corps to Mesopotamia, and the retirement on December 17th of Field-Marshal Lord French.

The Appendixes contain the Orders of Battle and give the most important Operation Orders in full. There is a useful Index of Place Names at the beginning of the volume, and a good General Index.

Accompanying the volume is a sheet of Addenda and Corrigenda to Vol. II, 1914, additional to those issued with Vol. III, and some pages of Addenda and Corrigenda to Vol. III itself; with the usual request that officers who notice errors and omissions in the volume under review should communicate with the compiler.

H.B.-W.

SHIKAR.

By LIEUT.-COLONEL C. H. STOCKLEY, D.S.O., O.B.E., M.C., F.R.G.S., F.Z.S. (Constable, 12s. net.)

It was only in the last number of the *R.E. Journal* that a book, *Big Game Shooting in the Indian Empire* was reviewed, and the author of that excellent and scientific work has now published this series of tales of shikar which are fully up to his high reputation as shikari, naturalist, and writer.

The book will appeal rather to those who have tasted the delights of shikar in India than to those for whom those delights are in store, and more especially to those whose greater interests lay in the hills rather than in the plains; but to none can it be dull. While, naturally, all description of shikar must stress the successes rather than the failures, the latter are not forgotten.

The author has captured the atmosphere of Indian shooting in a delightful way, which to each one will bring back his own recollections, and for those who have not the gift of the pen to put them down in

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writing for themselves this work will help to keep them green. A diary kept day-by-day is a most important part of one's outfit, and no outing should be thought too trivial for mention in it. This book is evidently the result of keeping such a diary. Experiences such as those described in the chapter " A Mixed Bag " are, one fears, a thing of the past ; but some such red-letter day will come to everyone who tries hard enough. The description of the female of the *tahr* as a " ewe " seems strange, but as it has the authority of all those letters after the author's name one doesn't like to question it. There is a chapter on the Lesser Kudu in Somaliland.

By those interested in this subject nothing from Lieut.-Colonel Stockley's pen should be missed.

ANON.

SIX BRITISH SOLDIERS.

By THE HON. SIR JOHN FORTESCUE. (Williams & Norgate, Ltd. Price 12s. 6d.)

This is an account of the careers of six typical British soldiers, which shows how they had to make the armies which they used, and how they often had also to make the policy to fulfil which they were employed. Cromwell, Marlborough, Abercromby, Stuart, Moore and Wellington, had each to face the difficulty which is inevitable in the case of a British Army in a large war. The military forces maintained in peace are always inadequate and must be expanded. Such expansion in the days when a reserve did not exist was carried out by all sorts of expedients, all of which filled the army with untrained officers and men of very doubtful value. The commander had then to form and train from this indifferent material the force he was to use.

Nor was this the only difficulty. Generally the war involved co-operation either with the Navy or with foreign allies, with every possibility of friction and misunderstanding. Such difficulties would have been less serious if there had been always a definite policy outlined by the government. But " there has rarely, if ever, been an efficient directorate of war in London, and perhaps there never will be." In consequence, these British commanders often had to help to frame the policy which they, with their armies, were to put into effect.

How each in his own way dealt with the difficulties makes most interesting reading. It shows very clearly that the personality of the Commander has an enormous effect, both in the making and training of troops and in their employment. This effect did not end with the armies of the day, but lives on in the spirit and traditions of the army as we have it now.

This book adds one more to the series for which the army is indebted to Sir John Fortescue, and it is one which all soldiers can read with profit and enjoyment.

N.W.N.-C.

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THE LIFE OF GENERAL LORD RAWLINSON OF TRENT, G.C.B., G.C.V.O., G.C.S.I., K.C.M.G., FROM HIS PRIVATE JOURNALS AND LETTERS.

Edited by MAJOR-GENERAL SIR FREDERICK MAURICE, K.C.M.G., C.B., LL.D. 1928. (Cassell & Co. Price 25s.).

This is a book worth reading. Sir Frederick Maurice was perhaps fortunate in the material he found available for the history of Lord Rawlinson's career, but he has made good use of it, and, incidentally, has increased his own reputation as a biographer.

The lives of great soldiers and great statesmen are usually worthy of study, and repay the reader. The *Life of Lord Rawlinson* is of special interest, for not only was he a very distinguished soldier, but he proved himself also to be a great statesman in the way that he handled the problems of India in his capacity of Commander-in-Chief and military adviser to the Viceroy.

His death is a national loss, and the loss is the greater coming, as it did, at a time when the future of India was about to go once more into the political melting pot. This record of his life will make a good many people, who thought they knew all about "Rawly," realize how little they knew of his great qualities. "It was," writes Sir Frederick Maurice, "a misfortune for his reputation with some of his contemporaries, as well as for the State, that he died a comparatively young man —he was only 61—in the fullness of his powers, for later achievement had not had time to outweigh fully early impressions."

Naturally a large portion of the book is concerned with the Great War. This will be of particular interest to those who served with him in France, for Lord Rawlinson had views on most of the problems which have been so widely discussed since the Armistice. But the real value of the book is to be found in the two concluding chapters on the Defence of India, and entitled "The Problem" and "The Solution." Readers of the earlier chapters will soon recognize the qualifications which Lord Rawlinson possessed to enable him to take a leading part in the discussions with the Government of India on the future of the Army in India and the Defence of India, which are described in the subsequent chapters. Those qualifications came partly as a gift of heredity from his distinguished father, and partly as the result of close intercourse with many of the men who had studied the subject on the spot for the last half-century. The story of the development of the young soldier who discovered ambition as a subaltern in India on the North-West Frontier in 1884, and achieved his ambition by being Commander-in-Chief in India before he was suddenly cut off in the zenith of his career in 1925, is a most interesting one for anyone to follow, and should be read by every officer who looks forward to service in the East.

H.B.-W.

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SOME RAMBLES OF A SAPPER.

By BRIG.-GENERAL H. H. AUSTIN, C.B., C.M.G., D.S.O. (Edward Arnold & Co. Price 16s.).

In these pages we must not expect to find the Broken Soldier telling us how fields are won. General Austin is rather a Ulysses who, wandering from clime to clime, observant stray'd. And yet here are no Syrens, no Nausicaa, and so perhaps it were best to liken him to the Kindly Uncle, whose stories may be trusted to enliven the dull hour before bedtime, now summer-time is ended. True to this type, he promises us even more exciting tales on his next visit, for he has reserved his adventures during four expeditions in the Dark Continent for a future volume. Sympathetic readers will follow the General's career in this book with considerable interest, and regret that it came to an end so prematurely.

F.E.G.S.

FOUCHÉ, THE MAN WHOM NAPOLEON FEARED.

By NILS FORSSELL. Published in 1925 and since revised. Translated from the Swedish by Anna Barwell. George Allen & Unwin, Ltd. 1928. (Price 12s. 6d.)

In training oneself, or teaching others, to become an efficient member of the Intelligence Branch of the General Staff, it is difficult to find books dealing with the methods of the famous secret service agents of history or furnishing any guide to the training by which those methods were developed. For obvious reasons, they or others destroyed their detailed records, and we have to be content with studying maxims, dating from centuries B.C., which have from time to time been collated. Maxims are all very well, but one requires more than a knowledge of principles to develop into a successful Intelligence Officer. It was in the hope of at last finding a key to the acquisition of this knowledge that one greeted the publication of this "Life of Joseph Fouché," the famous secret service agent and Minister of Police of the Revolution and Napoleonic era. Frankly, one is disappointed, and not for the first time. But this study of Fouché's life and character is worth reading. To most of us he is known as the most famous "double spy" in history. The "double spy" is no new development. The *Book of Sonshi* mentions him. One wonders whether Fouché had access to the translation of that work by the French Jesuit missionaries in China in the eighteenth century, a copy of which was at once produced by the late F. J. Hudleston in the W.O. when Calthrop's English translation of a portion of the book reached his library from Japan in 1904–5.

The volume before us is an attempt to show the development of Fouché's character from earliest youth, and how he achieved success, if success it can be called. The writer succeeds in giving us a most interesting narrative of a life which must have been crammed with excitement and was certainly fraught with danger. He also gives us, in an appendix, a complete bibliography of books dealing with Fouché and his times, which will enable the student to learn some of the details of Fouché's

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methods. Fouché was a political spy first and foremost. His activities embraced the whole of Europe and the British Isles. The amazing feature of his career is how he contrived to earn the confidence of the principals of both sides in the many intrigues in which he had a finger, and how by his farsightedness he managed to anticipate the course of events, and so came out on the right side after each crisis. He was a wonderful judge of character, and could sum up a man, or a woman, with unerring precision. Woe to the spy who served him badly! Born of Breton seafaring folk, he began life as a teacher, after teaching himself to be a mathematician.

Mr. Nils Forssell traces the development of his character, and rather inclines to a more generous view of his actions than is accorded him by most of those who have written about him. He sums up as follows:—

"The delicate little teacher was a precocious youth, with a brain that "quickly registered without effort his observations in the schoolroom, "and exercised supreme control over subjects of study, conversation and "outward behaviour. His class offered a fruitful field for psychological "experiment and observation, for, as a member of the Oratorian Order, "was it not his duty to guide every pupil to the goal most fitted to his "natural gifts? Thus Fouché tested on living, growing material the "theories which he had formulated concerning human vices, passions, "and dreams. . . . There is always a decided touch of the pedagogue "in Fouché's not unkindly sarcasms, and in the unfailing deliberation "with which he met even the smallest of life's happenings. He is calm "in storm, and ready with the least expenditure of force to deal with "disturbing situations, and by a wise admixture of pardon and punish-"ment to restore order once more. If at last we ask how this man, "with his delicate physique, was able to endure the constant upheavals "of this terrible time and to survive its unceasing storms, we shall, "perhaps, find the most credible answer in the great help of the regular "methodical work that upheld Fouché through fair and foul weather, "and never failed to steady his estimate of favourable prospects and "risks. Of the many personal associations that Fouché made, there was "never one that he willingly dropped. It has been noticed that a "constant feature of Fouché's personal policy was never to make "enemies, for in his opinion nothing was so calculated to complicate and "envenom any situation as feelings and prejudices of so unreasonable "and inexplicable a nature. He declared that nothing could be more "contemptible than to allow changes of fortune to affect personal "relationships."

The book is perfectly translated, and might have been written in English. The Index is hardly complete enough to be of real value.

H.B.-W.

ON FUTURE WARFARE.

By COLONEL J. F. C. FULLER, C.B.E., D.S.O. (Sefton Praed. Price 12s. 6d.)

This volume is made up of reprints of articles contributed by Colonel Fuller to various service magazines between 1919 and 1927. The

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majority of the material is, therefore, not new to students of the military profession.

The eighteen chapters cover a wide field, from consideration of tactical and strategical principles to discussion of the employment of the various new mechanical developments in the field.

Colonel Fuller is well known for his advanced, or even futuristic, views on the art of war, and one may, therefore, approach his writings with a certain expectation of finding therein violently revolutionary doctrines. If such an idea is entertained, it will speedily be dispelled. The first chapter, on the principles of defensive warfare, reprinted from the *R.E. Journal* for June, 1925, might almost have been written by one of the General Staff against whom the author inveighs so continuously. The fact is that Colonel Fuller accepts the principles of *Field Service Regulations*, and attempts to apply them according to his own ideas. So obsessed is he, however, with his own doctrines, that he apparently loses sight of those of others. This is exemplified by his statement, in the footnote to page 93, that the following principles of war were adopted by himself before the publication of his book, *The Foundations of the Science of War*, in 1926:—The principles of the Object, Offensive, Security, Concentration, Economy of Force, Movement, Surprise, and Co-operation. We seem to have seen something similar in *Field Service Regulations, Vol. II*, 1921! Colonel Fuller is, therefore, not so heterodox as some, including himself, would try to make out.

Some may not be able to keep pace with his deductions as regards future war, but, as we all start on common ground, we can each see how far we can travel along the road with him. Frankly, in the majority of these articles we can travel almost all the way, even though we may not accept some of the author's arguments, or his more sweeping assumptions. From a certain limited standpoint Colonel Fuller is undoubtedly right, but he neglects, or rather cursorily discounts, certain important aspects, such as the policing duties of the army in India and in certain other parts of the world.

It is perhaps in the psychological discussions that we are least convinced by Colonel Fuller's arguments. The new weapon invariably produces insensate terror in the enemy, older ideas are met by ridicule. The picture of the war of the future in Chapter XIII seems to indicate that increase in mechanization will necessarily produce a lamentable state of "nerves" among the armies of the future. We feel that the author is rather like a psycho-analytical doctor who has no real understanding of the individual. His psychology is based on too rigid rules, and lacks the true milk of human kindness. Doubtless the author possesses this excellent quality, but it does not ring true in his book.

Space does not permit of a detailed analysis of the various chapters, but we feel that they will repay very close study. We have each got to make up our minds as to the warfare of the future. Our decision must be based on a full appreciation of the principles of war and an understanding of the various factors which tend to change its practice. We can imagine no better way to reach a decision than to read this book a chapter at a time, not in the spirit of carping criticism or blind conservatism, not in a spirit of revolution, but with a determination to elucidate the truth.

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If we examine every argument, and compare every statement with the facts as known, we will be able to form a judgment of our own which we venture to think will coincide in many important points with that of Colonel Fuller.

But, where we agree, let us remember we have not reached that degree of mechanical efficiency which Colonel Fuller frankly admits as futuristic, and when we have achieved it we have still much to do to solve the many administrative, tactical, and directional problems entailed.

AIRMEN OR NOAHS.

By REAR-ADMIRAL MURRAY F. SUETER. (Pitman. 25s. net.) Reprinted by permission from *Times Literary Supplement*, August 30th, 1928.

A year ago, in *The Great Delusion*, certain strong and disturbing views were expressed by a writer under the name of " Neon " on the civil and military policies of aviation. He questioned what he called the " strange doctrine " that aircraft are of vital importance for transport in peace, and that they will be the decisive factor in the next war. The reasons for his opinions concerning airships were supported by what were stated to be facts and figures which, if correct, corroborated his view that all airship work on the part of the State should cease completely, and that those who believe in the future of these vessels should look elsewhere than to State funds for financial support. " Neon " deplored similarly and for fundamentally analogous reasons the sums lavished in subsidies upon civil aviation. The test he applied to the practicability of the civil uses of aeroplanes was the purely economic one. If traders or private individuals consider aeroplanes indispensable or desirable, and are willing to pay for them, private enterprise will infallibly produce the supply, as it had in other forms of transport. " Neon's " third principal point was that the bombing of towns by aircraft is indiscriminate, barbarous, a bad policy even when used against " native " races, and, in the long run, a futile one. He did not by any means deny the value of aircraft for ancillary purposes, such as spotting for artillery, long-distance scouting at sea or reconnaissance on land, dropping food to beleaguered garrisons, or moving small bodies of troops. But he claimed that the expenditure of money between 1919 and 1926—£160,000,000—was unjustified either by its results, by any principles of economics, or by the well-established theories of war. Finally, he made some critical remarks upon the utility of the Home Defence Force. That force has as its *raison d'être* the defence of London against air attack. Drawing his conclusions from remarks by persons in high authority, " Neon " came to the conclusion that those forces which Parliament votes for the purpose of the defence of London are not intended to be used to prevent the city from being bombed, but to make war of their own upon enemy civilians, leaving the real defence of the city and its inhabitants to the guns and searchlights of the Territorial Army and the nerves of the people.

Such, in broad outline, were the principal indictments of aerial policy

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brought by " Neon ," and it is to refute these " extraordinary, inaccurate and unusual " views that Admiral Sueter tells us he has written *Airmen or Noahs*. It is, however, difficult to believe that this alone has actuated him : for it was not necessary, in order to refute those views, to conduct a continuous stream of invective against the Admiralty of the pre-War period and against the Admiralty shipbuilding policy of to-day ; nor to give us one whole chapter describing his own share in the development of the tank, another on his proposal to establish a Ministry of Defence and yet another on the Schneider Cup. None of these can be said to be relevant in any degree to " Neon's " criticisms ; while the personal note and what can only be called the cheap ridicule with which he attempts, with much repetition of phrase and example, to cover the officers of the Admiralty, are as eminently distasteful to read as they are unconvincing so far as his thesis is concerned. For they prove nothing and have no bearing on the Neonic theories.

Admiral Sueter's initial aim is to show that aircraft made a contribution to victory. We had believed that this was fully recognized and in need of no proof—though Mr. Pollen certainly offered an opportunity for criticism in his remark in the Preface of *The Great Delusion* that that contribution was " pretty hard to find." To this object he devotes a chapter on Naval Aviation which describes some of the feats of the naval airmen in the air and on the land. Fine work was done by these officers, as he shows. But this has been done—and, we might say, with greater skill—by the late Sir Walter Raleigh. The sections on " Should Submarines be Abolished? " " The Blocking of Zeebrugge," " Should Battleships be Abolished ? " have in reality nothing to do with the question. Where he might well have enlightened us he does indeed refuse to do so. After describing in some detail the minor details of the life at Otranto, and giving the congratulatory letters of which he was the recipient, he leaves us in the dark as to their results. " Whether our air efforts in the Lower Adriatic were of value, others are better judges than I am." But since the aim of the book would seem to be to inform the reader of the value of such operations as these, this conclusion can hardly be described as adequate or convincing.

On the subject of airships, and " Neon's " views that State assistance to their construction should cease, Admiral Sueter replies with a description of his own activities in attempting to get airships built before the War, in the face of obstruction by the Admiralty ; of accounts of flights made in airships on several occasions ; and of a positive statement that the German Zeppelins enabled the German Fleet to escape after Jutland. The evidence upon which Admiral Sueter makes this statement—and he is so convinced of its importance that he prints it in leaded type—appears to be a statement by a German, who quotes an American, who quotes a " secret " British report that the Zeppelins saved the German Fleet. Before making this claim, Admiral Sueter would have been very well advised to study the battle and verify the possibility of the statement being true. The fleets were over thirty miles apart at the time of the sighting of the Zeppelin and the British Fleet would have had to steam at a speed of not less than 65 knots to intercept the enemy before he entered the minefields. Not less inaccurate is his statement that the Germans

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kept the whole North Sea under close observation with their Zeppelins. Jutland and the movements of the convoys are among the many proofs of the extravagance of this remark.

To " Neon's " contentions that airships are lacking in carrying power, and that in consequence they suffer from economic inability to function commercially, and of their liability to injury and other matters, Admiral Sueter offers no reasoned reply. The airmen, he tells us, desire to link up the most distant parts of the Empire by air—a wish admirable in itself. " Neon's " point, however, was not whether such linking up is desirable, but whether the State should spend money upon uneconomic enterprise. To be sure, to Admiral Sueter's mind, the enterprise is not uneconomic; it is an investment of the people's money, by the State, in an eventually more profitable, because well-peopled, Empire. His arguments are those invariably used by the technical enthusiast. His claim is that the State should spend its money, at the dictation of a small body of such enthusiasts, upon an undertaking the success of which is, even in his own opinion, open to doubt. The taxpayer, in Admiral Sueter's opinion, ought to feel fully compensated for the loss of his money, if the experiment fails, in the satisfaction he will derive from the fact that its energetic protagonist " has made a big endeavour to solve a great air problem." The taxpayer, however, has a tendency to desire some better return for his savings than a Platonic satisfaction.

The view that the specialist should dictate a national or a departmental policy informs much of his argument. It is accompanied by a not uncommon concomitant: that wars are won by material. " History," he confidently remarks, " teaches us that success in war has been in part due to those who adapted the science of the period to produce a new weapon—a flint axe, a spear, or some form of protection." From precisely what events in palæohistory Admiral Sueter draws his lesson we are not told; but it would be equally interesting to have chapter and verse for his statement concerning events of a more recent date. To what " new weapon," for example, did Marlborough or Turenne, Napoleon or Moltke, Frederick the Great or Nelson, Chatham or Carnot, owe their remarkable victories? The material side is unquestionably by no means negligible; but it is far from embodying the art of war to the extent Admiral Sueter supposes. A prodigous employment of material, as a French general has recently pointed out, did not give victory either at the Somme or at Verdun; what was lacking was skill in leadership; and that will never be replaced, however much it may be assisted, by the submarines, tanks and aircraft which the Admiral appears to suppose to be the queens of battle and war.

If " Neon's " book disturbed the minds of many, Admiral Sueter's can only increase that disturbance. Confidence in any defence of a policy depends upon the accuracy of facts, the sobriety with which they are used, the manner in which the several criticisms are met, and the avoidance of irrelevance, heat, or personal feeling. The characteristic features of this book, which cripple it as a serious contribution to the study of a problem of profound interest and importance, are the striking absence of reasoned argument, the loose statements, the irrelevant narrative and the acrimonious invective; and a sense of humour, verbal

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and pictorial, of a kind thoroughly enjoyed in the early period of our schooldays. Perhaps the most succinct summary of the aims of the book occurs in the author's own preface, in which he quotes his typist as saying, " How much you must have enjoyed writing every word of it, and *didn't you get your own back on the Noahs!* "

[*The Great Delusion was reviewed in The R.E. Journal for September, 1927.—Ed.*]

SURVEY OF INDIA, GENERAL REPORT, 1926 TO 1927.

FROM 1ST OCTOBER, 1926, TO 30TH SEPTEMBER, 1927.

Published by order of Colonel Commandant E. A. Tandy, R.E., Surveyor General of India.

This report follows the general lines of the previous annual reports of the Survey of India.

As the result of the recommendation of a Committee appointed by Lord Curzon in 1905, the department was to have devoted all its energies from that date to the production of a new series of topographical maps of India on a scale of 1 inch to 1 mile. Though this series was designed to be completed in 1930, owing to lack of funds, and delays due to the War, not more than half the task had been completed up to last year, in spite of the fact that the scale of survey has been reduced. To quote the words of the report, " though new surveys covering an area about equal to England are carried out every year, maps of half the country are still very old and only kept up to date roughly by means of rather perfunctory information supplied by local officials." Maps dating before 1905 are not thought worthy of a place on the index charts. This is certainly an unsatisfactory state of affairs, which is unfortunately due to lack of foresight on the part of our administrators, and it is not confined to the mapping of India only. As a result these " new " maps of India are in part over 23 years old and, if things go on as at present, will be some 45 years out of date before the next revision takes place.

For some reason, our rulers can never be made to appreciate what a country suffers economically from the want of up-to-date maps; this especially applies to new countries awaiting development, the progress of which is undoubtedly hampered in many directions where no accurate maps exist.

It is not easy to see how the maps of a great area like that of India can be kept reasonably up-to-date, unless the more rapid method of aerial photography is largely adopted.

Perhaps the most notable event of the year under review is the completion of the first topographical survey of Nepal, which was begun in 1924. In that year, H.H. the Maharaja of Nepal asked for the co-operation of Indian Surveyors in the preparation of a complete modern map of the whole country, the completion of which has made a most important contribution to Himalayan geography, and has given us an accurate knowledge of the drainage and mountain structure of some 55,000 square miles of practically unknown country, embracing some of the most elevated regions of the world, including Mount Everest itself.

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The field work was carried out on a scale of 4 inches to 1 mile. A skeleton map, showing watersheds and drainage on a scale of 1,500,000, has been reproduced with the report. Considering the many difficulties which had to be overcome, both climatic and topographical, the mapping of Nepal is no small achievement, and reflects great credit on all concerned.

The observatory at Dehra Dun has co-operated with other national observatories in the simultaneous determination of longitudes by means of wireless time-signals, which was organized by the International Longitude Commission. It is of interest to know that the determination of the longitude by wireless time-signals occupied two months, while by the old method, using telegraph lines, it occupied some two years. The latest value only differs from the former value, determined about 30 years ago, by 0·02 seconds of time, or about 10 yards in the relative position of Greenwich and India, regarding which the report remarks, " during the last 30 years there has been no measurable change in the longitude of India of the type involved in Professor Wegner's hypothesis."

An account is given of the exploration of the Shaksgam Valley by Major K. Mason, M.C., R.E., when about 1,500 square miles of new ground was surveyed by the plane-table, and this area will be increased when the photographs taken have been plotted by the Wild Stereo-Autograph. A full report of the scientific results of the expedition will be published later on.

It is a matter of regret that other survey departments do not follow the excellent example of the Survey of India and publish reports of exactly what they are doing, as a great deal can be learnt by an interchange of this kind of information.

H.L.C.

SURVEY OF INDIA, GEODETIC REPORT, VOLUME I.

FROM 1ST OCTOBER, 1922, TO 30TH SEPTEMBER, 1926.

Published by order of Colonel Commandant E. A. Tandy, R.E., Surveyor General of India.

This is the first volume of a new series of Geodetic Reports to be issued by the Survey of India. It deals with the scientific work of the Survey for the four years ending 1926 carried out by the Geodetic Branch, formerly known as the Trigonometrical Survey. It was under this name that it created for itself a world-wide reputation and some may regret the abandonment of the historic title, but we live in an age of change.

Probably no survey in the world has been engaged more consistently, or for a longer period, than the Survey of India on the scientific side of the subject, including the Great Trigonometrical Survey, on which the whole mapping of the country is based. This period extends from the time of Sir George Everest, who served from 1823 to 1843, to the present date.

We believe it is correct to say that, if the Geodetic Triangulation of India were to be re-planned to-day, it would take very much the form that

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Everest devised more than 100 years ago, though, of course, modern and much improved instruments would be employed. The Indian Survey was indeed fortunate to have had such a man guiding its scientific work at that early date, and it is true to say that the traditions he established have been worthily carried on through a series of able men who have succeeded him. The work of this Branch is grouped under the following heads :—Computing, Tidal, Observatory, Magnetic Observations, Gravity, Latitude, and Levelling.

The report, which treats of each in detail, should be of the greatest value to those interested in these subjects. It would be impossible in the course of a short review to notice all the items of interest with which this volume is filled ; it is, therefore, proposed to refer only to a selected few.

A remarkable chart has been drawn in the form of a map of India contoured so as to show the separation of the geoid, or the equipotential surface assumed by the ocean, and the spheroid, or the theoretical shape, as computed by Everest, which the earth would assume were it homogeneous, and not distorted by local attraction.

Owing to the neighbourhood of the Himalayan Mountains and the great mass of the Tibetan Plateau, this separation amounts in places to over 250 feet.

The chart in effect summarizes an enormous amount of field work and computation extending over years, and puts it into a graphic form.

A work of much importance to shipping in Indian waters, the Red Sea, and the Persian Gulf is undertaken by the Survey of India in the preparation of tide tables for some 43 ports, predicting in advance the times and heights of high and low water. Since the Tide Predicting Machine was transferred from England to Dehra Dun, Dr. de Graaf Hunter has introduced many improvements with a view to simplifying and shortening the work involved. Also an ingenious addition has been made to the Predicting Machine, by which the times the predicted height of the water reaches various selected heights above datum can be recorded. It is thought in some cases this extra information will be useful to shipping and to harbour authorities.

As is well known, the Survey of India has devoted much attention to questions connected with the physical constitution of the earth's crust, especially the mechanism of mountain building. Shafts and boreholes merely touch the fringe of this subject, as they can only penetrate to a comparatively small depth. Other means must, therefore, be devised by probing deep down into the crust. These present themselves in the form of the differences which have been found to exist between the spherical co-ordinates of places as determined by geodetic triangulation and by astronomical observations, and also by the anomalies displayed in the values of gravity derived from pendulum observations. Round these have grown up a considerable literature, and a theory known as the Theory of Isostasy has been propounded.

Those who wish to know what is being done in India with regard to this very interesting, but somewhat technical, subject are recommended to consult this report.

In passing, it may be mentioned that the introduction of wireless time-

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signals has greatly facilitated the determination of astronomical longitudes which form part of these investigations. It is also pleasing to note that we have at last established a wireless station at Rugby, broadcasting accurate time-signals which can be heard all over the world, making our Surveyors no longer dependent on foreign stations for their time.

As an accurate triangulation is of the greatest economical value to a country, so is an accurate and reliable system of spirit levels. They are not only essential to the making of maps, without which a country cannot be properly developed, but are of great use in engineering schemes affording reference data on which to base them. Accurate levels are now being extended into all parts of the country where public works call for them, and these are many in a land in which irrigation plays such a large and important part.

It is gratifying to see in the Survey of India a happy blending of highly utilitarian operations with scientific investigations, which might well be followed by other Surveys of the Empire.

As a comparatively new instrument of much interest to Surveyors, the prismatic astrolabe has been brought into use. With this instrument it is possible to determine latitude and local time in the same operation. Under favourable conditions, the report says, results comparable in accuracy with those of the Talcott method can be obtained. The chief advantages of the instrument are :—

(*a*) Simultaneous determination of time and latitude.
(*b*) Great portability and easy erection.
(*c*) Simplicity of observation.

The observations, however, were not so favourable when unsettled weather conditions prevailed, such as are met with in Himalayan regions, one part of the sky being clear, and the other part misty. Persistent errors were found to accompany this kind of weather. We think it is possible that the effect of these conditions is accentuated by the greater zenith distance at which the stars are observed compared with the Talcott method, when observations are taken in the meridian and close to the zenith. The instrument, however, may be considered as a welcome addition to the Surveyor's outfit and, together with the time-signal receiver, he is now able to find his longitude and latitude anywhere with much greater ease than formerly.

Before leaving this volume, we should like to draw attention to a lecture delivered by Dr. J. de Graaf Hunter at the Indian Science Congress at Madras in 1922, dealing with the height of Mount Everest and other peaks, which has been printed as Chapter VI.

Only those acquainted with the technique of the subject are aware of the methods employed and the uncertainties which surround the determination of the heights of inaccessible mountain peaks, which can only be viewed often from a great distance. Of all the various methods of determining height only one is available in this case, namely, the observation of the angle of elevation of the peak from a point of known height and distance. This sounds easy enough, and so it is, but the matter does not rest there, for we must take into account not only the effects of refraction, the Surveyor's bugbear, but the effect of local attraction on

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the value to the angle of elevation at the point of observation. All these have been carefully investigated and taken into consideration by the author of the paper under review, and he comes to the conclusion that the height of Mount Everest above the spheroid is 29,149 feet, with a probable error of 4·6 feet. Since the difference between the geoid and the spheroid varies from place to place, and its amount can only be estimated at Mount Everest, the final result of the height of Everest, above the geoid, is 29,080, with a possible error of 30 feet.

When the original value for the height of Everest was determined at 29,002 feet from observations in 1849–50, the effect of refraction on long rays was not so well understood as at present, nor, we believe, were the plumb-line deflections taken into account. It depended, as far as we remember, on about 113 observations taken from the plains of India at distances varying from 108 to 119 miles.

The investigation of the height of Mount Everest is not only interesting because it is the highest point on earth, but because it raises the question of exactly what we mean when we speak of height above mean sea level. For engineering purposes two points are said to be at the same level when, if we were to dig a canal between them, there would be no tendency for water to flow in either direction. In other words, they are situated on the equipotential surface, or geoid, passing through them. If one of these points is the station of observation, then the angle observed to the peak, cleared of refraction effect, is the angle of elevation measured from the tangent to the surface of the station. The height of the station is obtained by means of spirit levelling from mean-sea-level, which, for practical purposes, follows up the geoid from the sea. By this means we obtain the height of the peak above the geoid, as it exists at the station of observation, but what this same geoid may do on reaching the distant peak is a matter of conjecture. We believe, therefore, the determination of a height such as that of Mount Everest, does not admit of an exact solution, though the one given is probably not far from the true height.

H.L.C.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. BUILDING. RESEARCH BULLETIN NO. 3.

EFFECTS OF MOISTURE CHANGES ON BUILDING MATERIALS.

By R. E. STRADLING, M.C., D.SC., PH.D., M.INST.C.E.

(H.M. Stationery Office. 1s. net.)

An attempt is made in this Bulletin to summarize the principal relationships between water and constructional materials, and to indicate the results arising from these relationships.

Water, it states, can be present in building materials in three ways, namely (1) in chemical combination, (2) as free water, and (3) as "sorbed" water.

The first is analogous to the water utilized in slaking quick-lime, an operation in which the relative quantities of lime and water are fixed, and the chemically combined water can only be induced to leave the solid by breaking down the compound.

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The second is water associated with the material in such a way that its properties remain for all practical purposes unchanged. It remains thus associated only so long as the external conditions of the system are those of complete moisture saturation.

The last is the condition least known to users of building materials, and is intermediate between the other two. That is, the water, without forming a definite chemical compound, is held more firmly than free water, with a corresponding alteration of its properties, *e.g.*, boiling and freezing points. There is a definite relationship between the external humidity conditions and the quantity of water held in equilibrium in the solid. The application of the term "gel" is suggested to those materials, which have the power of "sorbing" water, with a corresponding increase in volume of the material.

The following effects of chemically combined and free water are explored:—Direct disintegration; solution; osmotic pressure; transmission; evaporation, efflorescence and crystallization; frost and the effect of freezing.

The influence of sorbed water on expansion, Young's Modulus, and breaking strength, is investigated, and a number of curves are given illustrating the results of experiments with regard to timber (ash), sandstone, cement, concretes, clay bricks and artificial stones.

A tabulation of the results of Professor MacBain's experiments, undertaken to determine whether the classification, as "gels," of those materials, which swell on contact with moisture, leads to the conclusion that the term is applicable, provided that it is recognized that they are of the "rigid," rather than the "non-rigid" category; the expansions due to this property are stated to be frequently greater than any temperature movement likely to occur in this country, and the danger of associating two "gels" of different expansion values is pointed out. A paragraph is also devoted to the irreversible changes brought about by the addition of water to such "rigid gels" as cement and concrete, and a possible explanation of the phenomenon of crazing deduced.

The effect of temperature changes on "gel" structures is illustrated by a table of the physical properties and permanent alterations in length, due to heating and cooling, of various sandstones, limestones, marbles, granites and mild steel, and it is pointed out that a general property of "gel" structures is the difference in the coefficients of thermal expansion in the wet and dry states.

The bulletin concludes by expressing a hope that, without losing sight of the general effects of moisture changes, special attention will, in the future, be paid to "sorbed" water relations.

A.D.C.

INTRODUCTION TO THEORETICAL PHYSICS.

By A. HAAS, PH.D. Translated by T. VERSCHOYLE. Vol. I, 2nd Edn. revised.

(Constable & Co. 21s.)

Physics of to-day is the forerunner of the engineering of to-morrow, and so it behoves every engineer to keep abreast of advances in physics.

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Unfortunately, time and opportunity are usually lacking, but this book is a good guide to the subject, and presupposes little but general mathematical knowledge.

The first part of this volume deals with the mechanics of a particle and of a rigid body, and with vector fields and wave-motion, leaving the theory of electromagnetism and light to be covered in the second part. Vector analysis is used as the basis of treatment throughout, its principles being very well, though briefly, explained in chapter one. This powerful weapon of mathematics is not in as general use as it should be. It was developed in a cumbersome form thirty years ago, by Hamilton and Tait under the awe-inspiring name of quarternions, and Heaviside was the first engineer to tame and use it for practical purposes. It has since been handicapped by the variety of notations employed by different writers, and the difficulty of writing vectors in manuscript. The notation employed by Dr. Haas is simple and clear, and the few small misprints are none of them of sufficient importance to fog the reader. Dr. Haas is to be congratulated on his avoidance of determinants, which most writers on vector analysis introduce into their treatment with no other result than to confuse the beginner.

Other points clearly explained in part one are the mechanical principle of relativity, the meaning of " degrees of freedom," and of tensors.

In part two, the theory built up in part one is applied to electricity and to light. It is interesting to the engineer to see how the fundamental laws of physics, which were first discovered empirically, can be derived to a large extent from considerations of theory alone. The electromagnetic field is merely one example of vector fields in general, and before going on to part two a reader should thoroughly master chapter seven on potential. The theory of light is built up from Maxwell's equations and Fresnel's theorems.

If volume two proves of equal merit to that before us the work will undoubtedly be the clearest book written on theoretical physics. Most engineers would probably benefit by more numerical illustrations. It is frequently necessary to refer back to previous paragraphs, and this would be much easier if the numbers of the paragraphs were shown at the top of each page.

K.H.T.

CAR MAINTENANCE AND REPAIR.

By A. W. JUDGE. (Chapman & Hall. Price 4s. net.)

This book is the fourth volume of a series called *Motor Manuals*, by the same author. It contains much useful information and advice for the user of motor vehicles (especially the owner-driver and the owner-driver-mechanic) concerning the maintenance and repair of a modern motor car. Chapters are devoted to the engine, chassis mechanism, tyres, electrical system, bodywork and upholstery, storage of the car, diagnosis of engine trouble, the text being very well illustrated with outside views and sections of parts of the better known makes of car.

The needs of the ordinary owner-driver have been carefully studied in

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this work, the language used being simple, and the order of arrangement of the subject matter logical.

The reader is assumed to know the broad outlines of how a car works, and the names and functions of the more important parts, and, given this knowledge, it will not be at all necessary for him to acquire the three previous volumes of the series (which are devoted to the working of the engine, carburettor, and chassis mechanism respectively).

As regards the value of the information and advice given, it should only be necessary to remind readers that the author is one of the most famous authorities on petrol engines, and he claims experience of motor vehicles covering a period of about 20 years.

Many owner-drivers, as a hobby, and many for financial reasons, elect to do much repair work themselves, and to these the book can be specially recommended, as giving sound advice as to what they can and what they can't tackle, how to tackle it, and the tools that will be needed. In this connection it should be noted that there is useful information concerning the layout and equipment of the garage, which will be particularly valuable to those who intend to work in it themselves.

The following is a list of some interesting items dealt with, which the average owner-driver knows little about :—

Detecting worn bearings by sounding rod ; quick cylinder decarbonization by burning with oxygen ; filling main bearings, both main and connecting rod ; testing and trueing crankshafts ; fitting new pistons ; carburettor adjustment ; non-freezing solution for the radiator ; causes of noisy gears ; suspension spring flattening, with effects and cure ; alignment of front wheels ; care of the battery ; storing the car.

It is to be regretted that the re-painting of cars is not dealt with. This is a job which could be carried out with satisfactory results by most owner-drivers provided they had a little information on the subject, and a little patience.

T.C.W.B.

RATIONAL MECHANICS, CHAPTERS IN MODERN DYNAMICS AND ENERGETICS.

By LIEUT.-COL. RICHARD DE VILLAMIL, R.E. (retired), author of *Motion of Liquids, Resistance of Air*, etc. Published by E. & F. N. Spon, 57, Haymarket, and Spon & Chamberlain, 120, Liberty Street, New York. (Price 10s. 6d.)

This work is partly a critical review upon the current theories of natural philosophy, and partly an exposition of the author's own views.

The subjects discussed comprise Dynamics, Relativity, Viscosity, Rigidity, Resistance of Liquids, etc.

A little of the criticism is captious, some of it destructive, but a great deal of it is so sound that I wish every Instructor of Elementary Mechanics could have a copy of it.

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The chapter on Relativity is disappointing ; that observed rectilinear motion is relative has, of course, long been known, but the logical consequences of this fact had not been fully appreciated before the time of Einstein. Just as Newton was led to his theory of gravitation by the fall of an apple, so Einstein, pursuing the fact of Relativity to its logical foundations, arrived at conclusions both startling and strange.

The chapter on Viscosity and Rigidity is interesting but contentious. The definition of Rigidity is not that usually adopted. Colonel de Villamil endows liquids and even gases with this property, and his reasons for this are quite plausible.

The resistance of a liquid to a moving body is ably and logically developed from the Newtonian theory in Chapters X, XI, and the book ends with three excellent chapters on the Principle of Least Action, and and the Shapes of Least Resistance.

Colonel de Villamil is no respecter of persons or theories, and his book is admittedly contentious. It embodies the result of very extensive reading, considerable mathematical knowledge, and no small amount of thought. The standard of criticism is high.

The work is not a treatise but an exposition of the author's views on a variety of subjects ; these views are ably and clearly presented, and it is open to the reader to agree or disagree.

There is much of interest in the book, which is well worth careful study by those who, not being necessarily mathematicians, are interested in the foundations of Natural Philosophy.

J.M.W.

STRAIN ENERGY METHODS OF STRESS ANALYSIS.

By A. J. Sutton Pippard. Longmans, Green & Co., Ltd. (Price 14s. net.)

This book provides an excellent account of the various ways by which the stresses in structures may be calculated by the use of the methods due to Castigliano. The book should be useful to R.E. officers at Cambridge and elsewhere who are studying the theory of structures, although the application of the methods is more likely to devolve upon aeronautical constructors and designers of complicated steel structures than on military engineers. Rather will the book convince R.E. officers of the importance of ensuring that any frameworks which they may design contain no redundant members.

The examples worked out at the end are a valuable feature of the book. The application of the method to a wooden structure is interesting, though it may be doubted whether the results obtained are of great accuracy in view of the large number of assumptions made.

The notation used in the book is not always very consistent, and is nowhere very satisfactory. For example, P_1, P_2, P_3, etc., are used to represent external loads on a structure, whereas P_s is used as a general symbol to represent the stress in any member. A little discrimination would have made the book considerably less confusing.

P.R.A.

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MAGAZINES.

COAST ARTILLERY JOURNAL.

The July number contains an article on the effect of Permanent Fortifications on military operations in the World War. It recounts the effect and fate of various fortified centres on the western and eastern fronts, and concludes that any fortifications must eventually yield to the assault of an attacker drawing on all available resources, and also that ring fortifications are doomed to be ousted by a continuous line of field fortifications with flanks resting on an efficient obstacle, such as some inviolate frontier.

This question is intriguing the French Government at the present moment, and has led to the suggestion for the immediate construction of two or three wired and defended lines from the North Sea to the Riviera at a cost of many thousand million gold francs.

The Gallipoli Campaign is a very favourite theme for writers in this journal: the last one concludes that the landing failed primarily because the Turks had at all times superior strength available on the spot.

The military situation of Holland is described. The home land has a population density of 546 per square mile, making it one of the most thickly-populated countries of Europe. The famous windmills are being replaced by electric pumps which act more efficiently in keeping the dyked land surface drained. The transport system consists of canals, roads, and rails. Canals form a great net of inland waterway: roads are made along the tops of the dykes: the railway net connects up the principal cities throughout the country.

The population of the colonies is about 50,000,000—over seven times as great as that of the home land. The Dutch military policy is based on compulsory but not universal service. Every Dutch male between 19 and 40 years of age is liable to military service, but only those who are drawn by ballot to fill the annual quota need serve. The term of service varies with the branch in which the time is served.

The Colonial Army is distinct from the Home Army: it is commanded by the Governor General, and consists of white and coloured troops though not mixed in the same companies except in the Artillery, where the gunners are white but drivers coloured. In all cases the officers are white, and in most cases even the N.C.O.s are white.

Officers and men in the Royal Navy must serve a regular tour in the Far East. The colonies afford ideal naval bases in cases of war in the Far East, and as such, might become a temptation to other maritime nations.

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Otherwise the only bone of contention, at the present time, is the command of the River Scheldt, which rises in Belgium but enters the sea through Holland. By the terms of an old treaty, Holland closed the Scheldt and then cut off the Belgian port of Antwerp from the sea, and, during this period, she increased the importance and trade of her own ports of Rotterdam and Amsterdam. Since the time of Napoleon, however, by a new treaty, Holland accepted the duty of keeping the Scheldt open, and this free passage enabled Antwerp to become one of the largest ports in Europe. But since 1918 Holland has become more and more remiss in clearing the channel, so that the banks are now seriously interfering with the traffic of Antwerp. The Belgian authorities have protested, and even offered to carry out the necessary dredging themselves, but the Dutch will not allow that, nor do they seem willing to do the work themselves. They also rejected a Belgian proposal for the construction of a canal to connect Antwerp with the Rhine mouth, and thus make her independent of the Scheldt. The Belgian Government has now referred the matter to the League of Nations: they feel that, though the mouth of the Rhine is in Holland, like that of the Scheldt, the Dutch would not care to take the same line with the very important international traffic borne by the German river.

In an article on the cruiser question, the writer explains his view of his country's needs: a first class navy, second to none, to ensure the inviolability of her merchant shipping in time of war, in every quarter of the globe in all circumstances.

The August number contains a description of the movement by rail of a 14-in. railway gun from the Aberdeen Proving Ground, Maryland, to Fort MacArthur, San Pedro, California. The weight of gun and mounting is 325 tons, and was distributed over twenty-eight wheels, giving approximately 11·6 tons per wheel. The journey covered 3,721 miles, crossed the Sierra Nevada Mountains, and took five-and-a-half weeks, which, however, included two hundred stops. These halts varied from a few minutes to ten days, and many of them were for propaganda, to enable the taxpayer to see the gun. Due to the poor condition of the bearings, the speed over the first part of the trip was kept down to about 10 m.p.h. Later, level tracks, with only slight curves, were negotiated safely at 30 m.p.h. At one time, a few miles were covered at 40 m.p.h., but an inspection revealed that the journals were dangerously hot.

The principal recommendations made after the journey by the officer in charge were as follows:—

(*a*) That journal bearings be at least 75% fitted before the mounting goes on the track. This would permit a maximum speed of 30 m.p.h. on the level straight.

(*b*) That the gun travel with muzzle to the rear instead of to the front.

(*c*) That a safety precaution be fitted to the elevating system between travelling and firing position, in case the normal raising screw should give way.

(*d*) That the gun car be so far divided from the loco, by means of flat cars, that both should never be on the same bridge span at one moment.

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In a talk on the Signal Service in the American Army, the lecturer showed that the volume of messages increased more or less in the ratio of the square of the mileage from the front line. The fighting area carries fewer messages, but under greatly increased difficulty: the signal service is there obliged to duplicate and multiply each channel of communication with as many alternate methods as human ingenuity can devise.

The traffic in rear has a vastly larger peak, but the channels require less troublesome maintenance. The largest volume of all lies between General Headquarters and Company Headquarters, and this volume is much the same as that between General Headquarters and the Seat of Government.

Meanwhile the tendency is for the depth of the fighting zone, with all its difficulties, to increase until it may include practically the whole theatre of operations. This means an increase in the urgency of all messages within this area, and an increase in the hazard of maintenance.

Not only this, but early and accurate information of operations have now to be broadcast over an area, instead of being required only over a single line to the local control at the rear end of that line. Thus, news of an enemy air-raid has to be sent at once, not only to the infantry and artillery commands, but to the anti-aircraft organization further back, and the defence fighter squadrons which may be ten or fifteen miles to the rear. Formations now demand communication both with moving tanks in front and the still more widely dispersed motor transport columns in rear.

The cult of mobility has introduced an increased strain on the communication system.

More and more must power-driven contrivances be pressed into the service of the overburdened human: automatic writers, ingenious selectors, automatic exchanges: everywhere the cry is for a fool-proof automaton; we must beware the fate of Frankenstein.

This trend demands a far higher standard of training and brain power for the successful control of these robots, and raises the question of an efficient and automatic pool for the replacement of those brains.

Wireless is now required in the front line within the battalion area, and, as such, is manned by operators belonging to that unit. Is there an adequate supply of such in the casualty replacement system? That seems to be the present menace to Frankenstein.

The writer points out that technical equipment is now ahead of the ability of the average personnel to make use of it and keep it in good order. The regiment, battalion, or battery must now preserve the balance by attaining the capacity to handle and care for it. The spread of this education must be more general than is usually imagined, now that nearly ten per cent. of the military force in a theatre of operation is engaged in operating and maintaining the communication net. In the American Expeditionary Force 2% of the Army belonged to the Signal Corps, while 8% of the Army was made up of officers and O.R. of branches other than the Signal Corps, but employed on signal communication. For each and all of these individuals there must exist a functional replacement system, extending direct from the central training reservoir to the

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most advanced unit, so that casualty replacement may be unfailing and automatic.

Into this scene of a trail of messages there gleams a ray of hope. The more highly trained and capable our commanders and their staff become, the more penetrating will be their foresight: the more strategically and tactically efficient our officers are, the more able are they to foresee and plan aright for the future: one message will do instead of three. This means less volume of work, and faster and better service: thus may we retain the whip-hand over our monster.

Industry and War.—At the outbreak of war, industry receives a serious shock. Millions of men are withdrawn from productive labour, and immediately become enormous consumers. Just when maximum production is required, a crippling blow is received by the industries on which we rely for our supplies. Industry must carry on with many green workmen, at the same time changing their product and increasing their output to maximum. Thus does the author of Industrial Preparedness for War state the necessity of planning ahead, in peace-time, to procure and manufacture, without delay and at minimum cost, the materials essential for carrying on a war. The Army and Navy Munition Board co-ordinates the requirements.

The United States has been divided up into procurement districts. Each district has a District Chief, a prominent civilian in the industrial world, assisted by an advisory board, and equipped with a clerical staff. Industries and factories are allocated to the corresponding production plan. Plant alteration is prepared on a factory plan which is agreed, and then tentative orders are indexed and issued.

On the outbreak, the War Department would notify each District Chief, from whose headquarters the authoritative telegrams would be sent to all producers to put into effect the pre-arranged plans for the production of war materials, and to approve the previously-agreed contracts. Transportation alone is left in the hands of private operation. It was taken over by the Government in the Great War, and much confusion resulted.

In an article on Recent Developments in Anti-Aircraft Artillery, the writer explains how their development is proceeding on the lines of the elimination of dead and profitless time. With the present accuracy of the gun and projectile, the outstanding object now is to cut down the useless period which must elapse between the instant of precise observation and the burst of the shell which was controlled by that observation.

The allowance of eight seconds for dead time was an average; it might have been six seconds or it might have been ten, but meanwhile the target is travelling at 50 yards a second. The less the dead and profitless time, the nearer is the future position of the target to its observed position, *i.e.*, the smaller is the radius of the sphere of possible displacement. The result to be aimed at is to make this sphere of possible displacement coincide with the sphere of rupture of the projectile.

The dead and profitless time is made up, first, of time taken in observa-

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tion, computation, fuze-cutting and loading; secondly, the time of gun-laying and firing; and, thirdly, of the time of flight, which governs corrections for wind and atmospheric conditions, etc. The first error is said to be decreased by the use of the new electric data-transmission dials from eight seconds to one-and-a-half; the second by the follow-the-pointer system, in which the gun is always laid. By this method there is said to be no appreciable increase on the one-and-a-half seconds of dead time allowed for computation, etc. The third error is decreased by the gain in muzzle velocity, which has been increased to 2,500 f.s. in the new 3-inch gun. It is claimed that this elimination of time error has doubled the average percentage of hits obtained. Guns are now kept continuously set at the proper elevation and azimuth, by torque amplifiers; these are driven by small motors, and are operated automatically from the distant observing station.

Continuous fuze-setting and improvement in the breech mechanism have enabled the standard rate of fire to be increased to 84 rounds per minute from a four-gun battery, with a maximum rate up to 110 r.p.m. at times.

A 4-inch A.A. gun was tested last year—projectile 33 lbs.; rate of fire 14 rounds per minute; range 14,000 yards vertically and 20,000 yards horizontally; muzzle velocity 2,800 f.s. A new tripod has been designed for the ·50 calibre A.A. machine-gun, as the old one vibrated excessively. A further multiple mounting is under experiment to increase the rate of fire and rigidity. It is to be mounted on a trailer, with the computer and height-finder in the towing truck, so as to take its place in a mechanized column.

Sixty-inch barrel type searchlights are used, four lights at the points of a square about the battery, and 1,500 yards from the guns: a sound locator is paired with two of each four lights to direct the beams. The light is carried on a truck, with crew and telephone wire to connect up to battery: the engine of the truck drives the generator: the latest light uses 250 amperes, but this powerful beam will be used as a pilot to pick up the target, after which it will be handed on to the 150 ampere lights for shooting purposes. The sound locator has been improved and provided with a sound lag corrector, to correct for known variables in sound, and also an electrical device for connecting it up with the beam through an automatic computer. As the locator horn moves, the computor is actuated to provide corrected elevation and azimuth, and the light moves automatically on precise data. If this development succeeds, it is claimed that the hearing of the sound made by the target will enable the lights to illuminate it forthwith.

D.M.F.H.

TIDSKRIFT I FORTIFICATION.

THE JOURNAL OF THE SWEDISH ENGINEER TROOPS. 1928. PT. IV.

1. *The Engineers' Colours and Emblems.*

In 1925, H.M. the King ordered, upon the regrouping of regiments, that the question of colours should be revised by a committee of officers and heralds.

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The Engineers, Flying Corps, and Train put forward to this committee a request for the issue of colours, which they had not previously borne.

The author then proceeds to discuss the emblems suitable for Engineers. He traces the growth of colours from the Roman standards, through the coat armour of knights, to the assumption of arms by countries and cities.

Eventually, he cites the use of heavy standards by foot soldiers, and light standards by mounted troops. He mentions the introduction of battle honours about 70 years ago. A short description follows of the ground colours allotted to Household troops, Cavalry, and Infantry.

In choosing an Engineer emblem, the choice of design was limited by the demands of heraldry, the necessity for conventional figures, and the correct heraldic application of colours.

A five-pointed star has long been used on maps to denote a fort. The surrounding of this star by a twelve-pointed star, indicating the outer fieldworks, makes the design more modern and still within heraldic conventions.

The pictures on p. 172 show an admirable grouping of this heraldic device with the arms of that part of the Triple kingdom (Svealand, Gotaland, and Norsland) to which the Engineer troops belong.

Svea ing.-kår.

Telegrafkåren.

E.E.R.

AN t-OGLACH—THE IRISH ARMY QUARTERLY.

VOL. I, NO. 3. JUNE, 1928.

Properly to appreciate the outlook of the Free State Army, two points must be borne in mind. First, the intense desire to make the Army (as everything else in the country) national in character and as unaffected by foreign influences as possible. In the second place, the position in which the authorities find themselves placed must be understood. Early in 1922, the process of transition from a Volunteer Force to a Regular Army was under consideration, but before any sound logical decisions as to the exact requirements of National Defence could be arrived at, the authorities were called upon to raise, train, and equip what came to be known as the "National Army," for the purpose of suppressing internal

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disorder. It was not until well on in 1925 that any real constructive work could be undertaken.

These two points are reflected clearly in the number of *An t-Oglach* under review. There is, of course, the " padding " of general articles on military operations, organization and tactics (including a very clear and simple explanation of Liaison with Artillery during the Attack), and, very naturally, in the Editorial Notes mention is made of the participation of Colonel Fitzmaurice in the first East-to-West Trans-Atlantic flight. The editor emphasizes the necessity of seizing the opportunity of Ireland becoming the Eastern terminus of the future trans-Atlantic air routes. It appears to the reviewer that, in view of the disadvantages attending Ireland's comparative geographical isolation as an air terminus for such routes, more profitable lines for exploitation would lie in the direction of meeting sea-borne mails (and possibly passengers), and distributing them by air to Great Britain and to the Continent. But the real interest of the Army at the moment is undoubtedly, " What are we for, and how are we to train for it ? "

The outstanding contribution is Major-General MacNeill's introductory address, which was delivered last February on the occasion of the inauguration of the " programme of Study and Research conducted by the newly-formed ' Defence Plans Division.' "

The Defence Plans Division is a department of the General Staff—a temporary department—in which are gathered together officers of all branches of the Service, including some who have recently returned from military missions to Great Britain and the United States. The work of the Division is divided into two portions. Stage A will cover preliminary general duties, during which all officers will go through courses in Organization, Tactics, Command, Military History, Strategy, etc., rather, it is surmised, on the lines of the " crammer's " courses so well known to Staff College aspirants. It is interesting to note that the basis of these studies will be founded on the methods and doctrines of the United States Army.

Stage B, it is stated, will deal explicitly with the study and solution of Ireland's particular problems of National Defence, and the " formulation of an Irish Doctrine of War," which having been determined, " Tactical Doctrines for each Arm of the Service, commencing with the Infantry as the Basic arm," will be considered. These will be followed by the discussion of problems of Organization, Equipment, and Supply, all with special relation to the natural resources of the country.

It cannot be expected that the conclusions of the Defence Plans Division will be arrived at in a few weeks or a few months, but the final form which the Irish National Army will take and its methods of training will be of great interest to all students of Military Science. In our army, we are dealing with a weapon which has been long established, a weapon with ancient traditions, one in which many methods have been tried and discarded, or tried and retained. In the Free State, we shall see the process of forging a modern Army from what is practically the starting post.

S.

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BULLETIN BELGE DES SCIENCES MILITAIRES.

(1928. TOME I.—NOS. 4 TO 6 INCLUSIVE.)

Les opérations de l'Armée belge. The account of the Battle of the Yser is continued in the three numbers of the *Bulletin* under notice: the events of October 29th to 31st, 1914, inclusive, being dealt with. A short account is given in No. 5 of the attack delivered by the Germans against the front of the Belgian 2nd Division during the night of October 29th–30th, in the early phase of which this Division was driven back from Ramscappelle. The French at once sent reinforcements to the Belgians, but in view of the difficulties existing on this part of the line, the French decided at midday to postpone further operations for the purpose of recovering the village named until later in the day. The advance of the French and Belgian troops was continued at 7 p.m., the signal for the assault against the enemy's position at Ramscappelle being given two hours later. The Franco-Belgian troops attempted to advance, but were held up at the Ramscappelleleed; in consequence, directions were given to discontinue the operations for the recapture of the village until the next day. Von Besseler, the Commander of the German III Reserve Army Corps, had intended to continue his offensive against the Belgian front on the 31st, but during the previous night he was obliged completely to modify his plans, owing to the success of the inundation operations carried out by the Belgian engineers (certain particulars relating to these inundation operations are given in all three numbers of the *Bulletin*). The operations on the portions of the front held by the B.E.F. and the French troops in Flanders are also briefly touched upon. October 31st, it is recognized, was one of the most critical days in the history of the B.E.F.: on that day, the British front between Zonnebeke and Messines—held by three infantry and three cavalry divisions and a small detachment of French troops—was violently attacked by 8 German Divisions; the troops on the left front of the British 1st Division were driven back at Gheluvelt, and at 2.40 p.m. the situation appeared to be so critical that a retirement, to a position within 2,000 to 3,000 yards from the outskirts of Ypres, was in contemplation by the Commander of the British I Corps; however, a counter-attack delivered by troops of the British 2nd Division fortunately restored the situation. During the evening, the British line was drawn back to the westward of Gheluvelt.

The operations in connection with the Battle of the Yser (October 18th–31st) are briefly summarized in No. 6, and a synoptic chart in relation thereto is also furnished. The losses sustained by the Belgians during this period were extremely heavy, and the strength of their formations was reduced to about two-fifths, on the basis of their normal establishment; details of the actual strength of the several Belgian cavalry and infantry divisions as at October 31st are given.

Du rôle de l'armée de campagne and des fortresses belges en 1914. Parts 2 to 4 inclusive of the contribution by Lieut.-Colonel Duvivier and Major Herbiet are given in the three numbers of the *Bulletin*. Part 2 (in No. 4) contains an interesting historical review of the basis on which the defensive positions on the Belgian eastern frontier and at Antwerp were

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provided. The initial phase of the Great War is also touched upon in No. 4 of the *Bulletin*. On August 2nd, 1914, when the German ultimatum was received at Brussels, steps had only recently been taken to bring about a reorganization of the Belgian Army; a brief account is given of the condition of the Belgian field army and the fortresses at this date.

The mobilization and concentration of the Belgian Army at the outbreak of the War and the Defence of Liège are dealt with in Part 3 of the article. German sources of information have been used in compiling the story of the events at Liège.

In Part 4 an account is given of the position taken up by the Belgian Army on the Gette, and of its retirement to the retrenched camp of Antwerp. Particulars are also given of the defence of Namur, and of the successful retreat into French territory of the Belgian troops from their defensive position on the Meuse through the narrow gap which existed on August 23rd between the German II and III Armies immediately south of the western forts of Namur. The Belgians, having reached the shelter of the French V Army, were conveyed without delay by rail and sea to Ostend and Zeebrugge.

Les Chars de combat. Parts 4 and 5 of the article by Major Liévin under this title are published in Nos. 4 and 5 respectively of the *Bulletin*. Matters affecting the armament of tanks and their crews; anti-tank weapons and conning arrangements are discussed in Part 4. The requirements in relation to light and medium tanks are dealt with in Part 5, and details are also given therein of some of the machines actually in use or under experiment on the Continent at the present day. Both parts are illustrated with photographic reproductions and sketches.

Napoléon 1er.—Sa vie et son œuvre. Part 2 of the article by Major F. Delvaux under this title is published in No. 4; it deals with the activities and work of Napoleon during the period of his First Consulship.

La marche à la bataille. Colonel Hans, of the Belgian General Staff, discusses in No. 5 matters affecting march discipline, advance guards, and supply columns, as affected by recent developments in armaments and by the progress in mechanization.

L'organisation de l'Armée tchécoslovaque. An outline of the organization of the Czecho-Slovakian Army is contained in No. 6 of the *Bulletin*. Military service is compulsory in Czecho-Slovakia, the physically and mentally unfit citizens being alone exempted from liability to serve. The Minister for National Defence determines each year the quota to be called up for enrolment and training. The army comprises 167 infantry battalions, including 1 tank battalion; 306 batteries of artillery; 63 squadrons of cavalry, including 3 of cyclists; 18 aviation squadrons; and 20 engineer battalions. The Engineer Arm is organized in 6 regiments, and 3 signal battalions of 3 to 5 companies—12 companies in all. Five of the regiments comprise 12 engineer battalions, 1 mountain battalion, 1 bridging battalion (5 service and 1 reserve company), and 1 mechanical battalion; the remaining regiment consists of 2 railway battalions.

Les délibérations de la Commission mixte. La couverture permanente de la frontière. The *Commission mixte*, appointed to enquire into the

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defence system of Belgium and matters affecting the organization of the Belgian Army, issued an *Ordre du jour* on April 3rd last. An article under the foregoing title is contributed anonymously to No. 6, and discusses some of the conclusions of the *Commission mixte*. After stating that it was impossible, under the present conditions of national defence, to provide for the immediate reduction in the period of active service in the Army as now established by law, the Commission proceeds to make certain recommendations as to the steps which should be taken to allow the necessary reforms to be carried out for the purpose of reducing the personal burdens in respect of military service. The first of these recommendations is that a scheme should be worked out as early as possible for the purpose of ensuring the permanent protection of the Belgian frontiers. An interesting analysis is made in the article now under review of the manner in which the problems, presented by the various forms of attack which may have to be met, might be solved by the Belgian General Staff.

W.A.J.O'M.

JOURNAL OF THE SOCIETY OF ARMY HISTORICAL RESEARCH, JULY, 1928.

Royal Engineers in British Columbia.

Under *Notes, Questions, and Replies* is given an extract from "Rambling Recollections," by the Rt. Hon. Sir Henry Drummond Wolff, published in London in 1908, which is quoted in full below :—

"The period (1858) was also one of interest owing to the foundation of British Columbia. An expedition of Royal Engineers was organized to go there. On their embarkation Sir Edward Lytton* made a speech, which has never till now been published, and which, to my mind, was one of the best he ever delivered :—

> Soldiers! I have just come to say to you a few kind words of parting.
>
> You are going to a distant country, not, I trust, to fight against men, but to conquer nature; not to besiege cities, but to create them; not to overthrow kingdoms, but to assist in establishing new communities under the sceptre of your own Queen.
>
> For these noble objects, you, Soldiers of the Royal Engineers, have been specially selected from the ranks of Her Majesty's armies. Wherever you go, you carry with you not only English valour and English loyalty, but English intelligence and English skill. Wherever a difficulty is to be encountered, which requires in the soldier not only courage and discipline, but education and science, Sappers and Miners, the Sovereign of England turns with confidence to you. If this were a service of danger and bloodshed, I know that on every field, and against all odds, the honour of the English arms would be safe from a stain in your hands; but in that distant region to which you depart, I hope that our national flag will wave in peaceful

* Edward George Earle Lytton Bulwer-Lytton, Bart., Secretary of State for the Colonies.

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triumph on many a Royal birthday from walls and church-towers which you will have assisted to raise from the wilderness, and will leave to remote generations as the bloodless trophies of your renown.

Soldiers! you will be exposed to temptation. You go where gold is discovered—where avarice inflames all the passions. But I know that the voice of Duty and the love of honour will keep you true to your officers and worthy of the trust which your Sovereign places in her Royal Engineers.

On my part, as one of the Queen's Ministers, I promise that all which can conduce to your comfort, and fairly reward your labours, shall be thoughtfully considered. You have heard from my distinguished friend, your commanding officer, that every man amongst you who shall have served six years in British Columbia, and receives at the end of that time a certificate of good conduct, will be entitled —if he desire to become a resident in the Colony—to 30 acres of land, aye, and of fertile land, in that soil which you will have assisted to bring into settlement and cultivation.

In the strange and wild district to which you are bound, you will meet with men of all countries, of all characters and kinds. You will aid in preserving peace and order, not by your numbers, not by mere force, but by the respect which is due to the arms of England, and the spectacle of your own discipline and good conduct. You will carefully refrain from quarrel and brawl. You will scorn, I am sure, the vice which degrades God's rational creature to the level of the brute—I mean the vice of intoxication. I am told that is the vice which most tempts common soldiers. I hope not, but am sure it is the vice which least tempts thoughtful, intelligent, successful men. You are not common soldiers—you are to be the pioneers of civilization.

Nothing more counteracts the taste for drink than the taste for instruction. And Colonel Moody will endeavour to form for your amusement and profit, in hours of relaxation, a suitable collection of books. I beg to offer my contribution to that object, and I offer it, not as a public Minister, out of public monies, but in my private capacity as a lover of literature myself, and your friend and well-wisher.

Farewell! Heaven speed and prosper you! The enterprise before you is indeed glorious. Ages hence, industry and commerce will crowd the road that you will have made; travellers from all nations will halt on the bridges you will have first flung over solitary rivers, and gaze on gardens and cornfields that you will have first carved from the wilderness. Christian races will dwell in the cities of which you will map the sites and lay the foundations. You go not as the enemies, but as the benefactors of the land you visit, and children unborn will, I believe, bless the hour when Queen Victoria sent forth her Sappers and Miners to found a second England on the shores of the Pacific.

Articles in this number of the *Journal* are: "The Diary of Lieut. John Barker" (concluded 1776); "The Death of Major-General James

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Wolfe" ; "The Colours of the British Marching Regiments" ; "The Order of Shotinge Wt the Crosbow" (a poem of the 16th century) ; "The Graves of British Soldiers at Concord, Massachusetts, U.S.A."

With this number is enclosed a slip giving an account of the Sixth Annual General Meeting of the Society. The President, Sir W. Hastings Anderson, suggested various ways of making the *Journal* better known ; *inter alia*, that specimen copies of the *Journal* might be sent to Serjeants' Messes, and also to Allied Regiments in the Dominions.

References to the founding of Sapperton and to other works done by the Sappers in the development of British Columbia will be found in the *R.E. Journal*, December, 1924, *The Supplement to the R.E. Journal*, September, 1922, October, 1927, and February, 1928.

P.H.K.

REVUE MILITAIRE SUISSE.

(1928. Nos. 1 to 6 inclusive.)

Du commandement. The article under this title appears in Nos. 1 and 2 ; it is contributed by Lieut.-Colonel Combe, who analyses therein some of the chapters devoted to the subject of "command" in Part 3 of the recently-issued Swiss Field Service Manual (*Instruction sur le Service en Campagne*, 1927). The first part of the article contains observations on the sections of the Manual which deal with the essential elements to be taken into consideration by a Commander for the purpose of arriving at a decision in relation to the employment of his troops whilst on field service ; the framing of orders ; and the place of the Commander during the progress of operations. The second part of the article deals with the sections of the Manual devoted to matters affecting the General Staff and the staffs of an infantry brigade, an infantry regiment, and a battalion.

La défense française en Haute-Alsace et l'occupation du Porrentruy en 1915–1916. This article appears in No. 2 ; it is an extract from the *Sous-Officier* (1927, Nos. 10 and 11), the Journal of the *Société fédérale de Sous-Officiers* (*Section de Genève*). Lieut.-Colonel P. Martin is the author of the original, and suggests in his article that the mobilization of the Swiss Army during the Great War, and the fact that it occupied the Porrentruy salient, had a considerable moral effect on the belligerents ; to the action taken by the Swiss Government to hold the Swiss Army ready for immediate active employment against any invader was it largely due, Colonel Martin thinks, that the belligerents respected the neutrality of Switzerland, and the Swiss people were spared the burdens and terrors of a foreign occupation of their country.

Le matériel de l'aviation militaire. The original article appears in No. 2 of the *Revue* and is contributed by Lieut. E. Naef, who refers briefly to the fact that steps are being taken to effect a reorganization of the Swiss Air Force during the current year ; he also calls attention to the types of aeroplanes in use in certain of the European countries, and discusses their characteristics.

Le service en campagne. An article under this title appears in Nos. 3 and 4 of the *Revue* ; it is contributed by Captain Montfort, who discusses

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therein the subject of outposts in the light of the instructions contained in the recently-issued Swiss Field Service Manual mentioned earlier in this notice.

La Suisse désarmée. The original article appears in No. 3 of the *Revue*; it contains an able and telling reply from Colonel F. Feyler to the Swiss pacifists, who are carrying on a campaign for the complete disarmament of Switzerland.

La contre-attaque. The original article under this title is contributed by Colonel Verrey and appears in Nos. 5 and 6 of the *Revue.* Colonel Verrey treats his subject in the light of the recently issued Swiss Field Service Manual; in the first part of the article he points out that the new Swiss regulations recognize two types of counter-stroke, known distinctively as the *contre-assaut* and the *contre-attaque*—the official definitions of these two types are quoted in the original article. The former term is applied to the type of counter-stroke which aims at thrusting back an enemy before he has had time to reorganize and establish himself in the position gained sufficiently long to receive reinforcements, *i.e.*, it is an attack launched without loss of time for regaining a definite objective. The latter term is applied to a deliberate attack, planned to take place with a considerable body of troops effectively supported by artillery and machine-gun fire.

Colonel Verrey draws attention to the fact that similar distinctions in relation to the character of counter-strokes are made in the latest French and German regulations; the French have named the two types *contre-attaque immediate* and *contre-attaque d'ensemble*, whilst the Germans speak of them as the *Gegenstoss* and the *Gegenangriff.*

Historical examples of both types of counter-stroke drawn from the Waterloo Campaign, the Franco-German War, and the Great War, are given and discussed.

W.A.J.O'M.

REVUE MILITAIRE FRANÇAISE.

(*July*, 1928).—In the third instalment of "*La bataille de l'Avre*," Commandant d'Argenlieu describes the operations of Général Débéney's First Army in the area west of Montdidier at the end of March, 1918. The most interesting point is that the Army Commander wrote in an order:—"If circumstances become so serious that a choice must be made between liaison with the French or with the British, the First Army will then maintain liaison with the French."

Lieutenant-Colonel Paquet completes "*La défense du Bois de Ville et de l'Herbebois*" in this number. The story is a typical one of trench fighting, and finishes with the success of the German troops, in their onslaught on Verdun in 1916, in capturing these two places after a heroic defence by the French. The article is really only of special interest to those who took part in the action or who know the country.

Général Camon continues "*Autour des batailles de Napoléon*" in this number. He deals with Napoleon's method of attacking his enemy from such a direction as to cut him off from his line of retreat. The two examples given are Friedland and Waterloo. At the former battle,

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the Russians were deployed with the R. Alle behind them, and Napoleon directed his attack so as to cut them off from the few bridges by which they could retreat. At Waterloo, he proposed to break through Wellington's left so as to seize the only line of retreat, the Brussels road through the Forest of Soignes. We all know how Napoleon was foiled by the bravery of Wellington's British and Dutch troops, and by the arrival of the Prussians.

Colonel Bailly begins "*Franchissement des fleuves en présence de l'ennemi*" in this number. He quotes Frederick the Great and Napoleon, the former stating that cunning is necessary to cross a defended river, while the latter wrote that it is practically impossible to defend a river line against an attack on a wide front. The writer then discusses three examples from the Napoleonic wars to show that big rivers, like the Rhine and Danube, can be crossed provided that the cunning laid down by Frederick the Great is shown. In the next number he proposes to apply the old methods to more modern conditions.

In "*La réforme de la justice militaire*," Capitaine Andrieux describes the law passed in France since the War dealing with military justice. The object of the law was partly to place military justice on a footing in which it is in no way subservient to the military command, but at the same time little or no more indulgence was shown to the military criminal.

(*August*, 1928).—The fourth instalment of Commandant d'Argenlieu's "*La bataille de l'Avre*" continues the story of the German advance at the end of March, 1918. More than one French counter-attack could not be carried out owing to the pressure of the German onslaught, but the First Army still succeeded in keeping contact with the British.

Général Camon concludes "*Autour des batailles de Napoléon*" in this number. He describes, chiefly from Napoleon's own reports, the battles of Austerlitz and Wagram. At Austerlitz, he succeeded in drawing on the Russians to attack him, and then shattered them with the famous flank attack. At Wagram, where his troops were not so seasoned, he dared not allow the Austrians so much freedom, but the idea of the battle was the same. Général Camon concludes by pointing out how different was Napoleon's idea of the offensive compared with that which imbued the French Army before the Great War. Attacking the enemy in flank is not the same as continuous attacks "pour prendre la gorge" as had been taught in France since 1870.

Colonel Bailly, in the second instalment of "*Franchissement des fleuves en présence de l'ennemi*," discusses the possibility of opposed river crossings in modern warfare. He points out how modern equipment favours the defence, on account especially of the increased range of guns and of mechanical transport for moving reserves. From this he draws the conclusion that, in crossing a big river held over a long front (obviously the Rhine is being considered), a determined attack must be made all along the front, so as to pin down the enemy's reserves. This may mean terrible losses, but only by this method can a crossing of this kind be effected.

"*Souvenirs militaires sur la révolution française*," by Capitaine Andriot, is only of historical interest. A recent exhibition of the French revolu-

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tion brings to light a number of papers concerning the military operations of the revolution, especially before the advent of Napoleon.

Lieutenant-Colonel Bru and Commandant Cortot begin "*Étude sur les opérations offensives entreprises pour la conquête et le nettoyage de la Ghouta*" in this number. The Ghouta was the stronghold of the Syrian rebels at Damascus in 1926, and operations had to be undertaken to destroy them. Owing to the area being thickly overgrown by vegetation, the operation was most difficult. Several columns were sent out to converge on the area from different directions, while other detachments barred the possible exits. After much severe fighting, in which the rebels acquitted themselves very well, the French were successful in beating them, but with considerable losses. Practically all the fighting was done by tanks and infantry, other arms proving of little value. In the next instalment, the writers propose to discuss the cleaning up of the area after the original battle.

(*September*, 1928.)—Commandant d'Argenlieu continues "*La bataille de l'Avre*" in this number. The final stages consisted of numerous attacks and counter-attacks, together with small German advances, but by the beginning of April the First Army front was stabilized just west of R. Avre. A point of interest to us is a brilliant charge by a brigade of Canadian cavalry just north of Morcuil on 30th March. Although the cavalry suffered very heavily, they succeeded in re-establishing the situation here, after a hole in the line had been formed by the retreat of the infantry.

Médecin-Général Uzac begins "*De l'ancien au nouveau règlement du service de santé*" in this number. Apparently the French medical arrangements in 1914 were terribly inadequate. The battles of Charleroi and Guise, to refer only to the 5th Army, produced appalling scenes on the railways. There were no proper ambulance trains arranged and the unfortunate wounded collected on any empty trains going back. It took a long time, during the trench warfare period, to build up an efficient system; but, by the end of the War, an organization, by which the wounded were properly dealt with, had been established.

In completing "*Franchissement des fleuves en présence de l'ennemi*," Colonel Bailly describes various successful river crossings carried out during the Great War. Unfortunately, most of these crossings were effected by the Germans against the Russians, who could not be regarded as up-to-date enemies. The Germans, however, achieved a remarkable success in July, 1918, when they crossed the Marne; but, again, the example is not a good one, as the Marne is not a big enough river. The writer sums up by pointing out what the attacker requires. Provided that he has the material, attacks on a wide enough front, and is able to blind both the enemy's weapons and the position of his bridges with smoke, Colonel Bailly considers that a general can always undertake a river crossing with every chance of success. This last instalment is the most interesting of the series and is well worth attention.

Lieutenant-Colonel Bru and Commandant Cortot complete their interesting article, "*Étude sur les opérations offensives entreprises pour la conquête et le nettoyage de la Ghouta*," in this number. The area was satisfactorily cleaned up and immediately the life of Damascus returned

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to normal. In reading the writer's conclusions, it is interesting to see how the principles of war crop up in all kinds of operations. In this one, careful preparation by the Command, combined with absolute surprise, were the bedrock of the French success.

"*Le corps des officiers d'administration et service d'État-Major et de recrutement*," by Officier d'administration Sanguinède, refers to the abolition of this clerical corps of officers in France after a duration of less than fifty years. The problem does not affect the British Army, which has no corps of this type. The writer points out the advantages gained by having this corps to look after the documents of the different staff offices and deplores the present necessity for its abolition.

H.A.J.P.

HEERESTECHNIK.

(*January*, 1928).

A Scientific Anniversary. At Tübingen University in 1883, Carl Cranz, student of mathematics and mechanics, was given as thesis for his doctor's degree "A theoretical investigation of the regular deviations of projectiles and of the best shape of rifling." His subsequent friendship with two directors of the great firm of rifle-makers, Mauser, confirmed in him the interest thus awakened in ballistics, and, during his twenty years' professorship at the Stuttgart Technical School, he founded a laboratory for ballistics and published three works on the subject: *Synthetic-geometrical Theory of Curves and Curved Surfaces*, *Theoretical Studies in the Ballistics of Rifled Weapons*, and *A Compendium of Theoretical External Ballistics*. By this time, Cranz's work was well known to the Gun-proving Commission, which had frequently asked him to undertake investigations on their behalf, and had also sent officers to take part in his laboratory trials. In 1904, he was selected as Professor of Ballistics at the Military Technical Academy, and also as Superintendent of the Government Ballistic Laboratory, which he was called upon to start. In a few years, he made this latter a model establishment for experimental ballistic research of world repute. Many of his publications henceforward took on a new character. Such are:—*The use of electrical instantaneous photographs for investigating the behaviour of firearms*, *A photographic method of measuring velocities and decreases in the velocity of bullets*, *The use of cinematography for investigating explosion-phenomena*, and *The use of D.C. Quenched Spark-gaps for cinematographic photography of projectiles.*

His knowledge and wide experience were of the greatest use to his country throughout the War, and he produced shooting tables of all sorts, from mountain and anti-aircraft artillery to trench-mortars, working indefatigably the while in order to improve the work and teaching of the Military Technical Academy when peace should come. The Treaty of Versailles, however, closed the M.T.A., together with other institutions which were considered as dangerous to Germany's foes, and Cranz's activities were transferred to a fresh field, the Professorship of Physics at the Berlin Technical High School.

The leading German military scientific journal does credit to itself in

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thus honouring a civilian who has given 45 years of his life to the study of ballistics—and the more so for the thoughtfulness of publishing such an article while its subject was still alive to appreciate it.

Weather and the course of weather-changes, by Dr. Kölzer. The general run of articles on the weather may be classified as " Hazy, with bright intervals." Dr. Kölzer's article is no exception to this, but at least he explains the haziness to us. He starts brightly enough, to the effect that meteorology has in recent years undergone a change, in that the state of the weather is now looked upon as a result of the movement of air-currents, rather than as a result of changes in atmospheric pressure. In support of this statement he cites :— Schmidt, *The interaction of vapour-masses in the open air*, 1925, published by Grand, Hamburg; Hann-Süring, *Manual of Meteorology*, 1926, and Süring, *Guide to Meteorology*, 1927, both published by Tauchnitz, Leipsic.

The author admits that the daily weather-charts do not as yet give expression to this change with uniformity, many districts in Germany keeping to the old system. Further, he thinks that the system of weather-prediction by means of pressure-changes will long hold the field. " It is characteristic of the weather that it is the condition of the moment, brought about by the combined effect of all the meteorological elements. Unfortunately, not even the experts can agree as to what these elements are, and in some text-books they are mentioned without being defined." The author gives as his own list of the more important elements : radiation received from the sun, and re-radiation from the earth (measured generally by the temperature of the air close to the ground) : atmospheric-pressure : humidity of the air : the amount of cloud present (including ground-mist) : rainfall (including other forms of moisture) : and finally, the wind.

After his initial comparison, it is disappointing to find that he could not make up his mind to give the wind higher than sixth place. Nevertheless he says " the movement of highs and lows is both as regards direction and time quite irregular, and depends upon very many factors, of which many escape direct observation and measurement. One is hence, even to-day and in spite of all progress of meteorological science, when deciding beforehand the probable positions of high and low pressure centres in the immediate future, really thrown back upon experience. This task forms the chief problem of weather forecasts. The changes in the weather in dependence on the position of high and low pressure areas do not make themselves felt by us through air-pressure, but in the first place by the wind. The origin of air-currents determines the temperature and humidity of the approaching air-masses, and with them also the weather of the place of observation." Then he hedges once more. " Consequently, the wind must also be looked upon as carrier of weather-changes."

The necessary warning closes the article, that as all the factors are not known, weather-predictions can be made only with a greater or less degree of probability.

How does one fight tank-targets, and with what effect ? Major Justrow doubts whether, between armies of equal strength, any very great importance is now to be attached to the tank, since the moment of surprise is past (? surprise of their *first* appearance), constructional details are

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pretty generally known, and anti-tank defence has been arranged accordingly. The fact that the tank is still a dangerous opponent for the Germans proves nothing to the contrary, for to a party not permitted to arm, any man with a stout stick can be fatal.

He then considers the questions of vulnerability, of weapons, projectiles, and penetration, and, on the plea that obstacles, mines, and tank-traps will be of very limited application in mobile warfare, confines himself to the side of the question which (besides the tank-troops themselves) concerns infantry and artillery, but not the engineer.

The Madsen Machine-gun. Notes taken from an article in the *Militaert Tidskrift*, by Capt. Jessen, of the Danish General Staff. This gun, designed by Major-Gen. Madsen in 1891, became part of the equipment of the Danish cavalry in 1903, has now been introduced into the armies of twenty different countries, and is still being produced in ever increasing numbers.

As the heavy m.g. is unknown in the Danish army, Capt. Jessen proposes to put the light Madsen on a carriage. This is a possible solution for any country which wishes to introduce heavy m.g's, but cannot face the expense of separate m.g. troops. The great advantages would be having a single type of m.g., ammunition of one calibre, complete uniformity of equipment, training, and supply.

The carriages would be company equipment, so that the company commander can change all or any of his 18 light machine-guns into heavy, as he finds desirable.

Capt. Jessen suggests that his types of light carriage are suitable even for armies already armed with a heavy m.g. They would permit of the use of the battalion heavy m.g's by battalion commanders, unrestricted by the clamour of company commanders.

Tables compare the dispersion at 200 metres and at 400 metres with Colt, Vickers, and Hotchkiss greatly in favour of the Madsen on light carriage.

One type of carriage weighs 9·3 kilos, and has a maximum height at butt of 67 cm.; another 12 kilos and 80 cm. Photographs show the gun on light carriage firing over a parapet, with butt at 36 cm., at 67, and at 80, for indirect fire, in action against aeroplanes (for which the heavier type has an arrangement of 360° traverse), and carried on the back on the line of march.

(*February.*)—*The great German Wireless Exhibition*, 1927. Wireless exhibitions in general run true to type. In accordance with the development of science and of industry, the centre of public interest shifts from year to year (in 1926, broadcasting receivers: in 1927, loud-speakers and arrangements for connecting with light-mains), but the exhibition itself remains a place where exhibitors (300 in this case) vie in showing the public their latest productions, and bidding for its favour by the ingenuity, simplicity, novelty and attractiveness of their exhibits. The value of a fair of this kind to the development of military wireless is, therefore, both limited and indirect.

Two points of general interest are that A.C. valves, already established abroad, made their first appearance on the German market at this

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exhibition, and that amongst the exhibitors was the German Post Office, not only with interesting historical exhibits, but also with a Carolus-Telefunken picture-telegraphy set, accepting photographs and hand-writing for dispatch, and thus doing some useful advertising.

Points in Vehicle-construction, by Major Giesecke. These notes deal with the subject on elementary lines, the wheel and axle, tilted and conical axles, axle-friction, and ground-friction, driving uphill, turning, high *v.* low wheels, breadth of felloe, and tilt of spokes.

The following averages are given for surface-resistance, compared with load=1,000 :—

Loose sand, 150 : soft earth or unrolled metal, 100 : dry, firm earth or muddy metalled road, 50 : uneven stone paving, 40 : dry, well metalled road, 33 : good stone paving, 20 : wood paving, 13 : asphalte, 10.

As regards felloe-breadth, a law in Prussia permits four-wheeled vehicles having :—

5 to 6½ cm.	felloe-breadth	to	carry	2	tons.
6½ to 10 cm.	,,	,,	,,	2½	tons.
10 to 15 cm.	,,	,,	,,	5	tons.
Over 15 cm.	,,	,,	,,	7½	tons.

Which figures show how much the authorities encourage broader wheels.

Recommendation is made of slightly conical axles with a very small degree of tilt, and wheels having the same small degree of tilt of their spokes.

How does one fight tank-targets, and with what effect? (continued). Major Justrow deals with tank penetration by artillery. As regards the use of gas-shell against tanks, he considers gas altogether unsuitable for use against tanks, which are not only capable of being rendered gas-tight, but which can travel quickly through the infected area. In any case, each of the crew can carry his own protection. Further, ordinary gas-shell is too weak to penetrate, while armour-piercing gas-shell with delay-action fuze would be as devastating against tanks as ordinary armour-piercing shell, but not more so to any extent which would justify the additional complications of fuze, bursting-charge, and gas-filling.

The author complains that while, on the subject of construction, armament, weights and speeds, much good sense has been written, especially in Major Heigl's publications, one will seek in vain in tank-literature a clear and exhaustive answer to the difficult question, " What firearm is the most effective in destroying tanks ? " The infantry-rifle is unequal to the task. A rifle should be of 12 to 15 mm. calibre and have a muzzle-velocity of at least 650 metres a second to be effective even against light tanks, and then it ceases to be an ordinary rifle. The critical calibre at which one passes from rifle to gun using the simplest form of explosive bullet is ·8". Such a weapon will be ineffective against heavy tanks unless its muzzle-velocity is over 1000 m. per sec., when we get a weapon liable to become out of order very easily when firing rapidly, of very short life, and quite unsuitable for mass-issue.

If a special anti-tank weapon is built, it must be effective against heavy

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tanks. The infantry-soldier cannot know beforehand what kind of tank is going to attack him, nor can he measure the armour of the attacking tank, so as to use against it only the appropriate weapon. He will, however, immediately discover whether the weapon he is using is effective or not, and, if the latter is the case, with disastrous results. Of what use is an anti-tank gun if its issue is limited?

Major Justrow hopes by writing in this manner to stir up a profitable discussion.

Fuel cares in France. The task of ensuring the provision of the fuel necessary for the compulsory mechanization of the army is an extraordinary source of anxiety to the French Government, and to the French military authorities. France itself possesses only small resources of oil in the mother country (chiefly at Pechelbron in Alsace), and apparently none in her colonies. This dependence upon the oil-production of foreign countries has led to great attempts, officially supported in every way, to provide at least for lorries to be gas-driven, and also for the use of alcohol, natural and synthetic. These efforts are alleged to have been successful. Whether more was hoped for, or whether the actual needs in case of war have been estimated at a very high figure, the fact remains that France is making extraordinary exertions to obtain as large a share as possible of the world's oil-production. Further, oil-importers are compelled under strict supervision to stock at least three months' supply at their previous year's rate of issue. A state-monopoly of oil has also been proposed in the Chamber, and a petroleum-commission of 44 members appointed to go into the question.

Independence of possible enemy countries is sought in two ways :—

(1) Arrangements with countries like Russia, Roumania, etc., which are wholly or partially independent of the English and American money-magnates; and agreements with import companies independent of the English and American trusts.

(2) Getting a share of the produce of oil-fields about to be opened up, as was the case in April, 1920, when the German share of the Turkish Petroleum Co.'s workings in Mesopotamia was allotted to France.

" The ruthless energy with which France thus strives to secure this, as all other factors of her supremacy in Europe, is worthy of admiration."

The Madsen Machine-gun (concluded). Photograph and figures are given of the new 20 mm. Madsen Gun, a normal Madsen m.g. on a larger scale, and intended as anti-tank weapon and for use against low-flying (up to 3,000 metres) aeroplanes; against armoured-cars, targets behind parapets, m.g. nests and infantry-guns within the range at which the strike of the bullets can be clearly observed; weight of gun, 53 kg., of carriage, 40 kg.; rate of fire, 200 rounds per minute; number of rounds in magazine, 15; maximum range, 6,000 metres; weight of bullet, 140 g. or 165 g.; muzzle-velocity, 750 metres per sec., or 675.

Capt. Jessen considers that every battalion should have six of these guns, while it appears still uncertain whether the 20 mm. Madsen can take the place of an infantry-gun. At the same time he recommends 4 light trench-mortars per battalion. The advantages of having light

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and heavy m.g. the same, differing only in that the latter has a carriage, and of having an anti-tank gun in the battalion of the same construction as the m.g. and differing only in size, are manifest.

Photographs are also shown of the Madsen m.g. for use in aeroplanes, a fixed pair for the pilot, and a pair on a ring-mounting for the observer.

(*March.*)—*Points in Vehicle-Construction*, by Major Giesecke (*concluded*). This month's instalment goes more fully into the details of the wheels, wooden *v.* metal naves, spokes, felloes, axle, bearings, and also deals with draught, the pole, and the best size of wagon. From the principles laid down, a 25 to 30 cwt. wagon should be designed as follows:

(1) Own weight as light as possible, *i.e.*, not over 10 cwt., so hard wood should be confined to the firm structure of the wagon, and to parts concerned in carrying the load: the use of steel and iron parts limited to axles, tires, naves, and the indispensable fastenings: a suitable relationship between axle and wheel-box: axle, say, $1\frac{3}{8}$" diameter.

(2) Tilt of axle and of wheel as small as possible; $\frac{3}{4}$" and 2" respectively will be sufficient.

(3) High wheels: when of different sizes, front 3′ 6", back 4′ 0": when of same size, 4′ 0". On account of overturning moment increasing, larger sizes are undesirable.

(4) Tires not too narrow, say $2\frac{1}{2}$" broad.

(5) Metal naves whenever possible. Roller-bearings would be considered only for wagons larger than 25 to 30 cwt.

(6) Wide track: 5′ is considered normal, and was laid down by the Standards Committee.

(7) A broad wagon-body, not too high (not over 25"), for taking bulky goods when necessary, also for ease in loading and for stability.

(8) Wagon-body as short as possible, for the best distribution of the load.

The Perfect Screw. This article shows that, whether the screw is used as fastener or for transmission of motion, the essential part of the relationship between male and female screw consists, not in their touching in all points of their respective surfaces, but in their relative movement.

If every point of the two screw-surfaces had to touch, male and female screw would have to be alike in seven separate measurements. In order, however, to prevent the bearing of the thread exclusively on its edge, and in order to facilitate manufacture, a certain amount of play is allowed both within and without. Thus, perfect equality is not aimed at in four of the seven measurements. The remaining three are the thickness of the thread at its base, the angle included between the two sides of the thread, and its height.

Diagrams show the effect, the other two dimensions being correct, of divergences in the size of the angle, and in the height of the thread. Whether these are too great or too small, the four pictures show that the result is the same. The distance between the flanks has to be reduced. Now, this should by all means be avoided, since it reduces the length of the flanks and thus the common bearing-surface of the male

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and female screws, which, as it transmits the energy, should be as large as possible.

The same faults occurring in the female screw have the opposite effects. In all four cases, the distance apart of the flanks would have to be increased.

Hence, to allow for possible deviations in height of thread and in the angle of flanks, a minus-allowance has to be made in the thickness of the thread at its base, and a plus-allowance in the corresponding measurement of the female screw.

Such an arrangement, instead of being "sticky," has plenty of play, but it can nevertheless provide the perfect screw, since the maximum bearing-surfaces touch each other and wear little by turning under pressure.

How does one fight tank-targets, and with what effect? (*concluded*). In Major Justrow's opinion, the anti-tank weapons worthy of serious consideration start at about 3·7 cm. (1½") calibre, the smallest size which is capable of providing the requisites—a strong enough armoured case, a safe delay-action fuze, a sufficiently large bursting charge, and a long-burning tracer. They must be capable of penetrating heavy tanks, but not the heaviest. The latter, on account of their enormous cost and of transport difficulties, will play no great *rôle* in the future, so that their appearance in masses need not be taken into account, and they may safely be left to the engineers to deal with, and to the medium and heavy artillery. This is an important consideration, since, if the anti-tank gun has to be capable of dealing with the heaviest tanks, its calibre must be increased, which means an increase of total weight, a decrease of handiness, while camouflage and especially ammunition-supply become more difficult. The upper limit is thus set at 5 cm. (say 2").

The larger calibres, especially of field-guns, 7·5 to 10·5 cm., are, of course, suitable for fighting tanks, but they do so only as a side-show, taking part in anti-tank defence when a target offers. In any case, they need special ammunition, at least a shell with an armoured head and internal or base-fuze, since ordinary explosive shell with sensitive fuze can achieve very little against good armour-plate over ¾" thick.

The author then joins issue with the writer of an article in the *Artilleristische Rundschau* on two points. He denies that large shell-splinters can certainly put tanks out of action, maintaining that a direct hit is necessary: and he denies that indirect fire with bracketing is a possible method of fighting tanks, being convinced that rapid-moving tanks can be dealt with only over the sights, and that the other method is a waste of special ammunition, which should be reserved until it can be employed with certainty of success.

In conclusion, after likening the tank to the battleship, to which the submarine is an answer, Major Justrow "does not consider technically impossible" a subterranean tank eating its way through the earth into the enemy's lines, where it would suddenly pop up! Then, as if he had sufficiently made his readers' flesh creep, he ends on the gentle note, that the party which concentrates its attention more on tank-defence than on tank-construction, will in his opinion reap the advantage in the long run.

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The limit of use of gas-masks with chemical filters. Reproduced from *Draeger-Hefte*, Luebeck. The question is so often asked—after some unfortunate occurrence—as to the limit of use of gas-masks with chemical filters, that it is necessary to answer it very clearly. There are two kinds of gas-protection equipment—(1) those either producing chemically their own supply of oxygen, or having it stored up in a small steel cylinder; (2) those which do not provide oxygen, so that the wearer is dependent for the oxygen he needs upon the surrounding air.

All gas-masks with chemical filters belong to the latter group. To the wearer of the former kind of mask, the composition of the surrounding air is a matter of indifference; to the wearer of a mask with chemical filter, it is of vital importance. Lack of oxygen arises either through oxygen consumption in combustion or through oxygen being crowded out by poison-gas. In the former case, CO^2 will be present, and perhaps even CO, and the use of the oxygen gas-mask is clearly indicated. In the latter case, matters are more complicated. From ·75 to 1% of poison-gas is a high degree of concentration, and in such concentrations the small filters in general use will have a low limit of service, even if the oxygen supply is ample. If there is reason to suppose a higher degree of concentration of poison-gas, a larger filter must be used.

Even when capable of dealing with the proportion of poison-gas present, no chemical filter is safe unless there is 15% of oxygen in the surrounding air (out of the normal 21%). If the percentage of oxygen sinks to 12, death from suffocation can ensue, while the filter is performing its office with perfect success.

When an accident happens, the newspapers are inclined to lay the blame on the gas-protection equipment, whereas generally the fault can be traced back to a lack of knowledge of the gas-conditions. In some instances it has transpired that these conditions had not even been considered. "Forewarned is fore-armed!"

F.A.I.

MILITARWISSENSCHAFTLICHE MITTEILUNGEN.

(*January–February*, 1928.)

Changes in the use and organization of Cavalry Divisions during the Great War, by Major Czegka. When one has arrived at the fact that no one has a monopoly of that commodity, it may often be both instructive and entertaining to note the folly of others.

In spite of the lessons of the Boer War and of the Russo-Japanese War, and disregarding the warnings of some of the younger(!) generation of cavalry officers, the Austro-Hungarian cavalry took the field in 1914, trained on principles gathered from the American Civil War and the Franco-Prussian War, and wearing their variegated uniforms, with full panoply of pelisses, cuirasses and head-dresses of metal or fur, for guarding against sword-cuts.

All these paraphernalia soon went by the board.

The article traces the changes forced upon the Austro-Hungarian cavalry "by the painful and bitter experience of 1914"—training to the

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fire-fight, adoption of service-dress, of the bayonet and the spade, down to their complete conversion into infantry, consequent on the loss of their horses.

In 1916 and 1917, owing to the remaining horses being wanted for agriculture and for the artillery, the cavalry were dismounted; and, to a famous cavalry regiment, the Windischgrätz Dragoons, whose exploits dated back to the days of Prince Eugène, fell the sad lot in November, 1918, of having to withstand on foot pursuing Italian cavalry!

Cavalry on the Western Front, 1918. This is a short report compiled by German G.H.Q. in October, 1918, at the request of Austrian G.H.Q. The French cavalry and the German cavalry are both dismissed shortly, while the British cavalry alone gets three-quarters of the report, coming in for much praise for its work on the 8th and 9th August, when its sudden appearance far behind the German front had a great moral effect, and where "it contributed greatly to the spreading of the success of the offensive." In carrying the British line forward, troops and squadrons attacked "with great gallantry," wherever they came upon them, detachments armed with machine-guns. At Harbonnières a cavalry regiment was put in entire and captured "a weakly held German line"—a solitary instance of the use of a large body of cavalry in close formation. Where British cavalry detachments pushed forward against German infantry, who kept their heads, they were shot down; but against badly shaken troops they gained "surprising successes."

Modern Cavalry, by Colonel Wiktorin. All the cavalry's old tasks remain, only the way they will be carried out has changed. The following is recommended as the composition of the modern cavalry division:—

Staff, with 12 motor-cyclists and a military police detachment.
4 cav. regts. (each of 600 men in 7 squadrons; 16 light m.g's, four to each of 4 cav. squadrons; 12 heavy m.g's, six to each of 2 m.g. squadrons; 2 cav. guns, signal troop and pioneer troop, contained in staff squadron).
1 rifle batt. of 400 men, carried on cross-country motor vehicles, with 18 light and 12 heavy m.g's.
1 cyclist batt. of 320 men, with 12 light and 8 heavy m.g's.
1 detachment of armoured cars.
1 light artillery brigade, 16 guns horsed, 8 guns mechanized, and 14 guns in A.A. section.
1 observation echelon of 12 aeroplanes.
1 signal detachment.
1 engineer co. mechanized, with light pioneer and bridging column; also detachments for medical, supply, M.T. and veterinary services.

The Light (Mechanized) Division.—An analysis of a series of articles in the *Revue de Cavalerie*, in which Col. Audibert compares a light (mechanized) division with a modern French cavalry division.

The light (mechanized) division is that which Col. Fuller and other writers propose should replace cavalry. The modern French cavalry division with which it is compared is of the general composition given in the foregoing article. Col. Audibert first states his reasons for thinking

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that the light (mechanized) division would be less effective in the performance of its duties than a cavalry division of the special type shown. He then applies the *argumentum ad hominem* by imagining them pitted one against the other, and shows why he thinks the cavalry division (of the special type) would win.

Manœuvres and Skeleton Exercises in Leadership, by Lt.-Col. Irlweck. Manœuvres are an essential part of the education of the troops, but the necessary avoidance of all damage to property, the necessity of respecting preserves, of sheltering the troops only where it suits the inhabitants, and of not interfering unduly with the time-table of the troops' daily routine, are all factors tending to make skeleton exercises more valuable for training in leadership than the manœuvres themselves. For such skeleton exercises, perfect familiarity with the needs and capabilities of the troops is the first requisite. Two more essentials are that all staffs be represented, and that signal communications be complete.

The War Railway Service, by Gen. Ratzenhofer. Every year "War-Measures" were revised in the offices of the Military Railway Service, beginning in October and finishing in time to be put in force on March 1st. This work necessitated an increase of between 80 and 120 officials during the winter months, including the commandants of 28 railway districts and from two to three officials from each directorate of State Railways and of each private railway. These measures fell under two heads, *viz.*, those applicable in common to all cases of war, and those applying to particular cases, *e.g.*, complete or partial mobilization, war against Russia, war against Italy, war in the Balkans, the transport of Italian troops under the Triple Alliance through Eastern Austria on their way to the Vosges.

A precautionary period and mobilization proper were both arranged for. The latter did not necessarily follow the former, and the most difficult task for the railways would be if they coincided.

When the revised War-Measures were issued each year on the 1st of March they became the basis of revision of the mobilization schemes of the troops.

The article then gives in detail the administrative changes in the Military Railway Service on becoming the War Railway Service, and the measures to be adopted by the railways to enable them to deal with the mass transport.

There were on 1st August, 1914, in the Austro-Hungarian Monarchy 92,000 covered goods trucks in working order, and they carried in the first weeks of the War two million men, two-thirds of a million horses and mules, and 200,000 tons of stores, in all a quarter-of-a-million truck-loads, or an average of three trips per truck.

Armoured Cars, by Major Heigl. The author, by means of photographs and short descriptions with the chief numerical data, introduces to his readers the latest patterns of armoured car in use in those European countries which are the most important as far as Austria is concerned.

The first two pictures show all that is permitted to Germany in this line, *viz.*, an armoured, but unarmed, wagon for the transport of troops, and the "Shupo" or Police Daimler, which carries two m.g's, and of which Germany is allowed to possess 150.

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Under Great Britain are described with photographs, the old Peerless, which took part in the battle of the 8th August ; the Rolls-Royce, the fastest of all armoured cars ; and the two Crossleys, M23 and M25, which are principally used in India.

Under France we are shown the White-Auto, which, as it carries a 37 mm. gun, is the most effective fighter among armoured cars. Partly on account of its low speed (12 m.p.h.) it is in process of being replaced by the Autochenille. This latter, being armoured and half-track, qualifies for inclusion in Major Heigl's *Taschenbuch der Tanks*, where it is described on p. 148 *et seq.*

The descriptions mentioned are prefaced by some general remarks on m.g. and gun-openings and on types of shutters. This important question, which applies to tanks equally as to armoured cars, has hitherto not been treated separately by Major Heigl, his remarks on the subject finding a place in the *T.T.* only in the chapter in which he tells of tank weaknesses for the benefit of the attacker. In the present article he goes into the subject from the designer's standpoint, beginning with the open gun-port of the White-Auto and of the light Vickers tank ; thence to the shield on the gun, as in the Rolls-Royce armoured car, the American Renault tank, and the heavy Vickers ; and finally to the tight closing m.g. mount, spherical, cylindrical, conical, and double spherical. —(*To be continued*).

A successful attack on an Armoured Car. An account taken from the *R.T.C. Journal* of a fight in a narrow street in Shanghai between a Chinese machine-gun and a Rolls-Royce armoured car. The range is given as fifteen yards, but no mention is made of how the Chinese gun and crew were protected. There were subsequently counted on the car 93 hits ; three bullets, however, went through the openings, wounded the driver and the other occupants, and thus put the car out of action. It was rescued and towed away by another armoured car, while others took up the fight.

The moral is drawn that even infantry may attack Rolls-Royce armoured cars with hope of success, not only because of the observation slits, but because the shield of the Vickers gun stands out six inches in front of the opening which it is intended to cover, and so allows free access to the interior of the car to bullets fired obliquely. The same applies to the older Italian cars and to the French White-Autos. An altogether more difficult matter is when gun and/or m.g. are mounted in tightly closing cylinders or spheres, as in the French tanks and the Czecho-Slovakian a.c's, and when the observation slits are slotted by means of a conical slot-cutter, so as to have an extreme external breadth of only 2 to 4 mm.

Discipline in the Bolshevik Army. Extracts from *Narodna Otbrana*, Sofia. " Disciplinary Instructions," a pamphlet of seventeen pages for the Red Peasants' and Workmen's Army, was issued last year. An obvious initial difficulty when attempting to make soldiers out of revolutionary " brothers " is surmounted thus :—" In order to explain the necessity for the subordination of the Red soldier, it is pointed out that it is not a question of subordination to the officers' class, but of a conscious recognition of the object and signification of the Red Army."

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Nevertheless, the Red soldier has to take an oath to keep " revolutionary discipline," and to obey all orders of those placed over him, commandants and commissaries (*i.e.*, military officers and political officers)." Revolutionary discipline " is then defined, point by point ; from which it is perfectly clear that it differs not at all from the discipline aimed at by all armies, old or new. The aids to obtaining this discipline are laid down, and, in addition to the usual punishments, include (1) Being posted as a defaulter, up to one month ; (2) Name and crime to be read out on parade of the unit ; (3) The same as (2) but on a ceremonial parade. There is on the other hand an entertaining list of rewards :—(1) Being thanked (*a*) on a ceremonial parade, (*b*) by means of an official letter, (*c*) in Orders ; (2) Grant of a short furlough out of turn ; (3) A present with appropriate inscription ; (4) A written testimonial publicly presented ; (5) Prizes and badges ; (6) Being photographed with the regimental colours ; (7) Being placed upon the roll of standard-bearers ; (8) Presentation with a sword of honour or pistol of honour with inscription and testimonial ; (9) Promotion out of turn ; (10) The Order of the Red Workmen's Flag ; (11) Grant of the Weapons of Honour of the Revolution ; (12) The Order of the Red Flag ; (13) Eternal inclusion in the Army List.

Apart from its list of inducements to good behaviour, there is nothing revolutionary about the discipline to which the Red Army is being trained, beyond its name.

In God-given Afghanistan as Guests of the Amir (published by Brockhaus, Leipsic). The review of a book by Lieut. Rybitschka of the Austrian Military Police, who was taken prisoner by the Russians at Przemysl, and sent to Turkestan, whence he escaped with two other officers to Afghanistan, where they were interned. The account of the events of that time owing to warlike embarrassments with England, culminating in the murder of Habib Ullah and the vengeance of Aman Ullah, is described as thrilling. Lieut. Rybitschka and the other Austrian officers, who escaped with him, were used as instructors to the Afghan Army, and an interesting account is given of their friendly relations with the chiefs of the wild border tribes. The book, which is called " a treasure-mine for the traveller, and a book of reference for the geographer," is also praised for its historical details, for its descriptions of lands and peoples, for its profuse illustration, and, finally, for its " avoidance of all dressing-up of adventures."

F.A.I.

REVUE DU GÉNIE MILITAIRE.

(*June*, 1928.)—There is an interesting article by Chef de Bataillon Petit on the work of railway engineers in Morocco. Since the construction of narrow-gauge railways in that country, *i.e.*, that from Casablanca to Rabat in 1911 and from Oudjda to Taza in 1912, sappers have been called upon to make the railway bridges suitable for road traffic. This was usually done by putting in extra I girders and replacing the wooden decking by one of ferro-concrete. A description is given of the construction of three bridges on the branch line from Aïn Defali to Aïn Aïcha along the valley of the Ouergha. At low water the width of the

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river was about 50 metres, and at flood 150 to 400 metres. It was desirable to make the spans as long as possible, so as to reduce the number of piers, " Pigeaud " girders were therefore used, providing spans of 22·5 metres. The river-bed consisted of gravel and large boulders and lumps of stone, below which was compact clay at depths varying from 2½ to 5 metres. The foundations consisted of caissons made of ferro-concrete sunk into the clay. The area of caisson had to be as small as possible, as pumping appliances were limited, so two caissons were made under each pier, one at each end. The caissons were constructed in rings on artificial islands made in the river-bed. Successive rings were added to the caisson according as it was lowered. The caissons when complete were filled with concrete and each pair forming the foundation of a pier was united by a slab of concrete reinforced with old rails. The pier consisted of two masonry pillars, joined above by a semi-circular arch.

There are pictures of the bridges during and after construction. There is an interesting and spirited account by Colonel Sergent of a small inundation carried out by the engineers between the French and German lines at Kemmel on May 23rd, 1918. At this time the French front was about half-way between La Clytte and Kemmel, facing south-east. There was a pronounced re-entrant in the line at Kaaleput, which was a source of danger. It was decided to strengthen this point by means of an inundation formed by damming the Viverbeck stream. To effect this, a small party of sappers filled up the bed of the stream by means of timber and sandbags at a place where it had been bridged by the English for a narrow-gauge line, the approaches being embanked. The stream at this point was 3·50 metres wide. The operation was successfully performed without the use of nails or mauls, but no record exists of the size of the inundation obtained.

In a well-illustrated article, an account is given of the launching of a steel road bridge over a canal by means of a floating support. This consisted of three boats joined together, on which a staging was built of two trestles and superstructure. Experience showed that the process of lowering and raising the support by pumping water in and out was delicate and tedious, and that it would be preferable to raise and lower the end of the girder by means of jacks.

(*July*, 1928.)—There is an article of 41 pages on the works carried out at Fort Douaumont at Verdun after its recapture, written by Chef de Bataillon Tournoux and Captain Gilson. It goes into considerable detail regarding the repairs carried out and the arrangements for defence.

(*August*, 1928.)—" The inundations on the Belgian front " by Major du Génie R. Deguent is the title of the first part of a long and interesting article. The writer starts with a reference to previous cases, in which inundations have been used for military purposes in Belgium, and then describes the complicated hydrographical system existing in the neighbourhood of Nieuport and Dixmude, through which the Yser flows on a level course. There are six navigable waterways in this area, namely :

(1) The Yser, which is canalized between Rousbrugge, 41 miles from Nieuport, and the sea.

(2) The canal from Ypres to the Yser called the Yperlée canal, which joins the Yser at the Knoche bridge.

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(3) The canal from Nieuport to Dunkirk, *via* Furnes.
(4) The Loo canal, which connects the Yser with the Dunkirk canal at Furnes.
(5) A canal joining Furnes to Bergues.
(6) The Plasschendaele canal, joining the canal between Bruges and Ostend to Nieuport.

All these canals are embanked, except the right bank of the Yser south of Dixmude. The dikes and the land between, which is intersected by numerous channels of various sizes, form a vast chequered area. Rain-water is carried off by evacuating canals, into which flow collector canals, which in turn receive the water from the countless ditches with which the land is furrowed. The name of "watering" (Flemish) is applied to the various divisions of this huge system, as also to the association of landowners interested in its preservation and working. Each "watering" is managed by a special body comprising a president échevins, a gréffier, and keepers.

The various "waterings" of the Yser region are :—

Lombartzyde—the system north of Nieuport, the waters from which are evacuated by the Nieu-Bedelf canal.

Vladsloo, Beerst, Keyem, Schoore, Crique de Nieuendamme—systems lying east of the Yser, the waters collected from which are evacuated by the Old Yser (the old unnavigable river-bed of the Yser).

Dixmude, Blanhaart, and others lying east of the Yser, which are evacuated by that river.

Furnes or Veurne-Ambacht, a large system south of Nieuport, between the Yser and the Loo, finally evacuated by the Veurne-Ambacht or Noordvaart canal, which communicates with the Old Yser by means of a siphon. A third evacuator of this area, the Koolhof, passes in siphons under the Furnes canal (*i.e.*, that which connects Nieuport with Dunkirk and the Loo canal) and joins an old canal, also called Furnes, debouching into the Yser west of Nieuport.

In addition to the above, there are other waterings west of the Loo and Furnes canals.

As can be seen from the plan, six canals, two navigable and four evacuating, debouch together at the north-east corner of Nieuport into what is called the "Channel of Nieuport" (really the mouth of the Yser), forming what the writer calls a crow's foot, whilst a seventh canal, the Old Furnes canal, flows along the west side of Nieuport, and debouches into the channel of Nieuport at the north-west corner of the town.

There are weirs and sluices or locks at the outlets of all the canals and at various points along them.

The writer then gives a brief account of the part Nieuport has played in war from its foundation in the 12th century, and how inundations have always been used to assist its defence ; there are three plans showing its condition in 1745, 1794, and 1855. The fortifications were demolished between 1853 and 1858, with the exception of a bastioned front with a demi-lune and a lunette joined to the other works by a covered way, all lying on the north side of the channel. These old fortifications, which had been preserved for sthetic and antiquarian reasons, played a useful part during the War.

The Belgian Army effected its retreat to the Yser on the 13th and 14th

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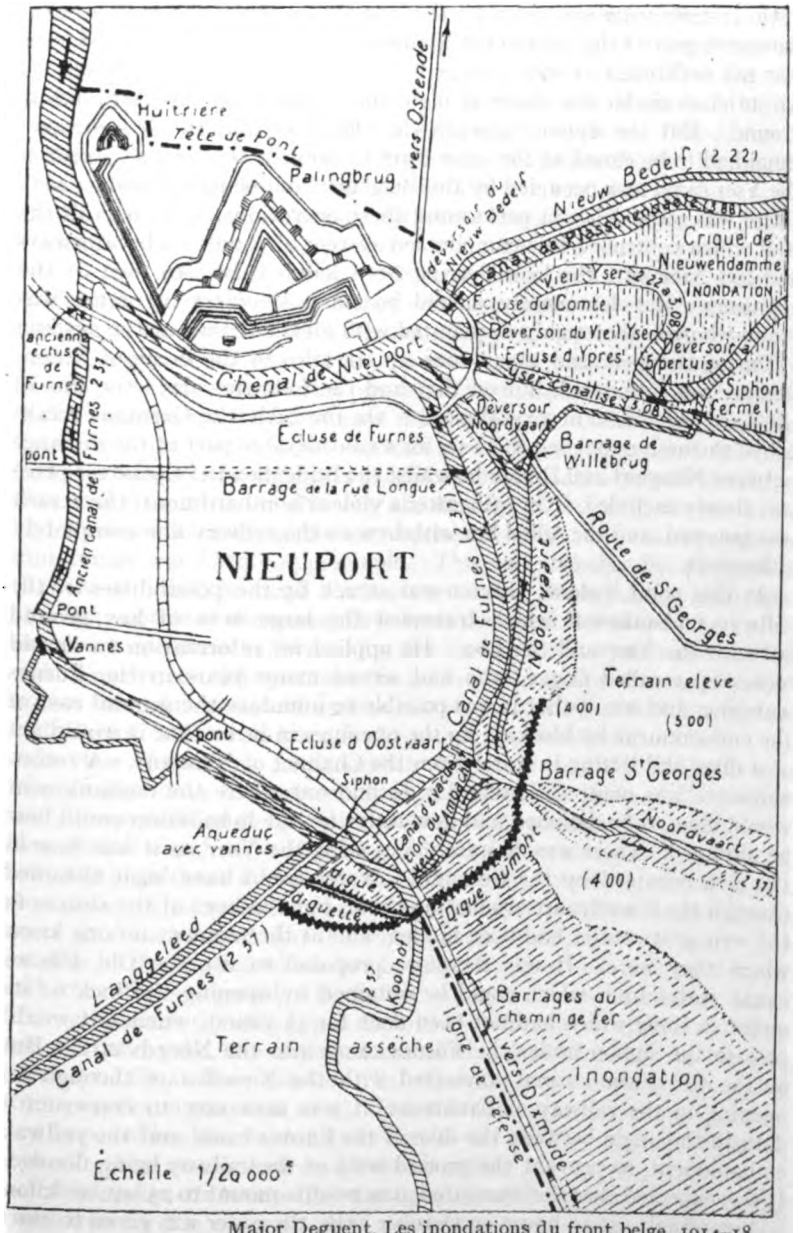
of October, 1914, and on the 13th Lt.-Col. Nuyten, of the headquarters staff, investigated the possibilities of inundation. On the 16th and 17th,



Major Deguent, Les inondations du front belge, 1914–18.
(*Reproduced by permission of Chef de Bataillon Roux.*)

the army was in position on the Yser with outposts beyond the river and bridgeheads at Nieuport and Dixmude in contact with the German army. On October 18th, the Germans attacked the outposts. Nieuport was

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violently bombarded, and a bridge (St. Georges) over the Yser was destroyed. The attacks were continued on the 19th and 20th, and positions north of Nieuport were forced.

On 21st, an order was given for the inundation of the creek of Nieuendamme to protect the right of the Nieuport bridgehead. As the Old Yser was not embanked, it was sufficient to open the sluices of the weir at its outlet to enable the water at high tide to inundate the surrounding ground. But the siphon between the Old Yser and the Noordwaart canal had to be closed at the same time, to prevent the ground south of the Yser canal now occupied by the Belgians from being flooded as well. There was some delay in performing these operations, as nearly all the staff which controlled this complicated system of canals and waterways had left Nieuport, the locks having been handed over to men of the engineers. But, fortunately, an old boatman, Geeraert by name, was found who was thoroughly acquainted with all the details of the system.

During October 22nd, about four square kilos of the creek of Nieundamme was inundated, but on that and the following days the line of the Yser was forced in several places. On the 24th, the Germans established themselves beyond the Yser for a considerable part of the distance between Nieuport and Dixmude, whilst the bridgehead at the latter place was closely encircled. On 25th, after a violent bombardment, the attack was renewed, and the Allied line withdrew to the railway line completely exhausted.

At this point, Colonel Nuyten was struck by the possibilities of the railway embankment which traversed the large area of low ground between the Yser and the Loo. He applied for information to an old lock-keeper called Cogge, who had served many years in the Furnes watering, and learnt that it was possible to inundate the ground east of the embankment by blocking up the openings in it, so that it would act as a dike, and letting in water from the Channel of Nieuport. A reconnaissance was made the same day to find out where the embankment would have to be dammed and how water for the inundation could best be obtained. There was no question of using the Yser, as it was now in the area occupied by the Germans. Water could have been obtained through the Noordvaart evacuating canal, but the keys of the sluices in the weir at its outlet had been hidden, and at the moment no one knew where they were. It was therefore proposed to use the Old Furnes canal, water from which could be obtained by opening the lock at its outlet (a thing which had not been done for 35 years), whence it would pass in the siphon under the Furnes canal into the Noordvaart. But as the Old Furnes canal connected with the Noordvaart through an opening in the railway embankment, it was necessary to construct a dam, in the angle between the dike of the Furnes canal and the railway embankment, to prevent the ground west of the railway being flooded. It was expected that the inundated area would amount to 25 square kilos.

Accordingly, at 16 hours on October 25th, the order was given to start work on damming the openings (22 in number) in the embankment. The work was carried out by Belgian engineers between the evening of the 25th and the morning of the 27th, the enemy being 300 to 400 metres away.

On the 26th, the situation became desperate; the artillery had run out

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of ammunition and the Belgian line had retired to the railway, which was to be held at all cost. In the evening, the bridgehead of Nieuport was abandoned, leaving the hydraulic works, which included those which controlled the sluices and locks in the " crow's foot," in the hands of the Germans. By the evening of this day, work was so far advanced that the order to inundate was given. At 4.30 on October 27th, Capt. Thys, of the Engineers, and Cogge, tried to open the gates of the lock at the outlet of the Old Furnes canal, but were unable to do so. The sluices in the gates were, however, opened, though the result could be but slight. Cogge then suggested making a breach in the east dike of the Furnes canal between the lock at its outlet and the railway bridge, and asking Dunkirk, with which this canal communicated, to supply water. The breach was made, but on the 28th information was sent from Dunkirk to the effect that no more water could be supplied, which is not surprising, as the tides on the 27th and 28th were not very high.

On the night of the 27th/28th, the gates in the lock at the outlet of the Old Furnes canal were at last opened. A gun had been laid on the gates so that they might be burst open if necessary, but if this had been done the inundation would have been subject to the rise and fall of the tide. It was arranged that the gates should open automatically with the rising tide, and close with the ebb. By the morning of the 29th, the third tide had occurred since the gates were opened, but the result in the shape of inundation was hardly appreciable. This was probably due to the fact that the soil and the small ditches intersecting it absorbed a great deal of water, and that the actual flow down the canal was obstructed by the numerous bottlenecks formed by the bridges over it, and also by the siphon under the Furnes canal, the ports in which only amounted to five square metres in area, and were partly blocked by objects such as barrels and planks, which had been floating about in the canal.

In view of this poor result, and the desperate condition of the troops, who for four days had been expecting the waters to come to their salvation, it was decided to open all the sluices in the weir at the outlet of the Noordvaart canal, with the rising tide, and close them with the falling tide, although these works were now in the area occupied by the Germans. And so, at 19.30 hours on the 29th, a small party sallied out, and with great good luck found that the weir was not held by the Germans. The handles of the sluices, which had been hidden in a bush, were recovered, and the sluices opened. High tide was at 21 hours, and at about midnight, when the tide began to ebb, the sluices were closed. At 6.30 hours on the 30th, the Germans launched a general attack on the line Nieuport-Lille. They reached the railway embankment and occupied Ramscapelle on the west of it. But the advancing floods had by midday appeared in the fields to the east of the railway, and the Germans retired. The waters had saved the situation.

It had taken 16 hours after the opening of the sluices in the Noordvaart weir for the water to reach a distance of 4 or 5 kilos. This happy result was largely due to the fact that the tides at this time were on the increase, and the wind was favourable. On the 31st, Ramscapelle was recovered and the railway embankment was reoccupied throughout its length. A.H.B.

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CORRESPONDENCE.

SCIENTIFIC SOLDIERSHIP.

The Editor, *The R.E. Journal.*

SIR,

With reference to Colonel MacLeod's letter, which appeared in the September number of *The R.E. Journal*, I will answer his points as briefly as I can.

1. *Infantry Armament.*

It is true that infantry may be given a weapon which will penetrate tank armour, but this weapon will not directly increase their mobility. It is the lack of mobility which I consider will eventually render infantry obsolete. Again, infantry cannot carry armour, consequently, in no way can they protect themselves *directly* against tank fire. At certain ranges the tank will be immune (whatever weapon infantry are armed with), whilst at no practical range will infantry be immune. The tank is, therefore, the only weapon which *on equal terms* can meet the tank (see paragraph 4 for artillery).

2. *The Bullet and Armour.*

Since 1861, there has been a general tendency towards static warfare. The reason is the rifle bullet. The Civil War in America, the first great rifle war, was largely a war of trenches, and during it, seven out of eight frontal attacks failed. The Franco-Prussian war saw trenches, but not many; yet neither Prussians nor French succeeded in a single frontal attack. The Russo-Japanese war was largely an entrenched war, and the World War was almost completely so. When both sides are equal in numbers and weapon power, theoretically it is impossible for the attacker to gain fire superiority, because one rifleman on the defensive can kill twelve to twenty attackers before he himself is killed. Why then waste time on inventing superior rifles and on more intensive musketry training (which the enemy may also do), when half-an-inch of steel will definitely kill the bullet.

3. *Armour and Morale.*

Armour is a means of protection; we talk of defensive armament, therefore, I think we are justified in calling armour a "defensive weapon," a shield, though technically this may be incorrect. In my opinion, armour has a potent moral influence on the soldier. For example: I am terrified if I am put into a den of lions; but if I am in a lion-proof cage in the den I have no fear. Again, outside a tank I am frightened by bullets, inside it I am not. It is not a matter of hiding behind armour, but of rendering myself immune to bullets, just as one renders oneself immune to rain by an umbrella. For this reason we are

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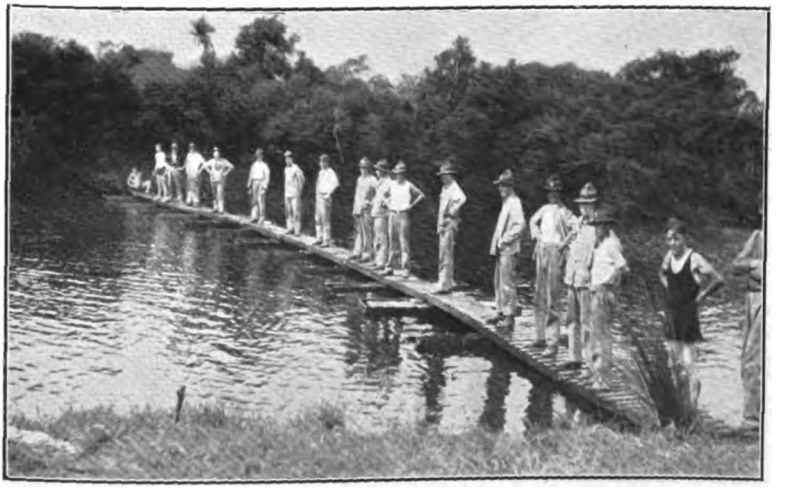
NEW ZEALAND LETTER.

Building Footbridge.



Footbridge in position.

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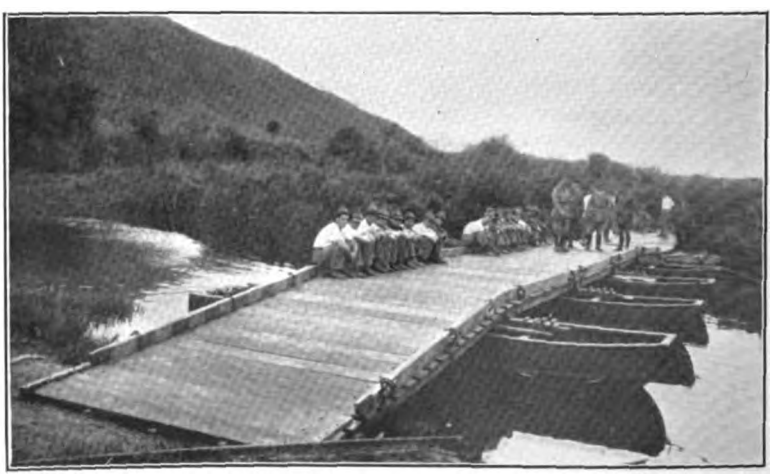
Launching Pontoons.



Pontoon Bridge completed.

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all very brave in peace time—there are no bullets. Mobility is gained by armour as it eliminates the bullet, and it is the bullet which restricts our movement.

4. *Armour and Effective Range.*

Suppose that infantry are armed with a weapon which will penetrate tank armour up to 500 yards range. Then at 600 yards the tank is immune, but the infantry are in no way so, even at 2,000 yards, from a ·303 M.G. bullet. To avoid guns, the tanks move behind them. If the guns are mechanically propelled, they may move as fast as the tanks. If these guns are unarmoured, they may move faster. But the tank can attack and defend itself with bullets and shells, and protected by its armour it can only be put out of action by shells. After the first of such actions, I think, the gunner would at once ask for protection against bullets, namely, armour, and given it his mechanized gun would become a tank.

In my opinion, all Colonel MacLeod's errors, if they are errors, pivot on the fact that he thinks of mobility, protection and offensive power in water-tight compartments, that is as separate quantities. In my opinion we must always think of them as inter-related, forming one compound —tactics—and not merely three un-unitable elements. In H_2SO_4 (sulphuric acid), H is as important as S, and S as O. In tactics, protection is as important as mobility, and mobility as offensive power. When these three are correctly related tactics flourish, when otherwise tactics do not. I think my theory of area warfare still holds good.

I am, etc.,

29/10/28. J. F. C. FULLER.

NEW ZEALAND NEWS.

THE Corresponding Member for New Zealand has kindly forwarded the photos reproduced, together with the accompanying letter :—

Headquarters,
Northern Military Command,
Auckland,
New Zealand,
15. 6. 28.

MY DEAR COLONEL,

I must apologize for not writing before. * * * * The photos I enclose are of interest to Sappers, and were taken during the recent camp of the Northern Depot, N.Z. Engineers, at Nyarawabia, where we have a mobilization depot for a Brigade Group. The great Waikato River runs past the camp, and the photos were taken on a tributary of the river. I am glad to say our Northern Depot of Sappers has at last good technical officers. It is one of the most popular units in the Command, and is what one may term a first-rate show. * * * *

Yours very sincerely,

J. E. DUIGAN.

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WIRE-NETTING ROADS.

With reference to the previous correspondence on this subject, Brig.-General C. W. Singer, C.B., C.M.G., D.S.O., writes: "*Re* wire-netting on sand roads, it may be of interest to hear that when we took over from the French at Nieuport, in the summer of 1917, many of their paths in the sand dunes were netted, and we kept up the practice."

RAILWAY DEMOLITIONS.

To the Editor, *R.E. Journal.*

SIR,

Major Simson's interesting article in the *R.E. Journal* for June, 1928, recalls one or two lessons on railway demolition learnt by the Railway Troops on the Western Front in the 4th and 5th Army areas during the Great War, and which seem in danger of being forgotten.

First: demolition of joints in flat-footed rails by charges placed *under* the rails is more effective than with those placed against their sides. A greater length of rail is rendered unserviceable, and repairs are much slower if wholesale track demolitions are done in this way.

Second: the destruction of trestle bridges by explosives hastily placed is always much more difficult than it appears at first. It is probable that charges consisting of plastic or powdered high explosive, such as dynamite or ammonal, placed in large auger holes made in the various members of the bridge, will always be more effective than slabs of gun-cotton laid against one or two sides as described in that article, because a greater length of timber is spoilt by the splitting action which results from the explosion. A hole filled with gun-cotton primers should have a similar effect.

The best way of demolishing such a bridge is, as Major Simson says, to set it on fire. But anyone who has tried to do so knows that this is not so easy as it would at first seem, particularly if the gap bridged is a wet one and the timber more or less saturated throughout in consequence. In spite of the application of almost unlimited petrol, the results of such an effort to set fire to one of the Somme pile bridges in the retreat of March, 1918, were poor. Ought we to add "Practical Incendiarism" to our training programmes, and carry equipment for this purpose?

Yours faithfully,
E. P. ANDERSON, *Lt.-Col., R.E.*

Lahore, 2nd Sept., 1928.

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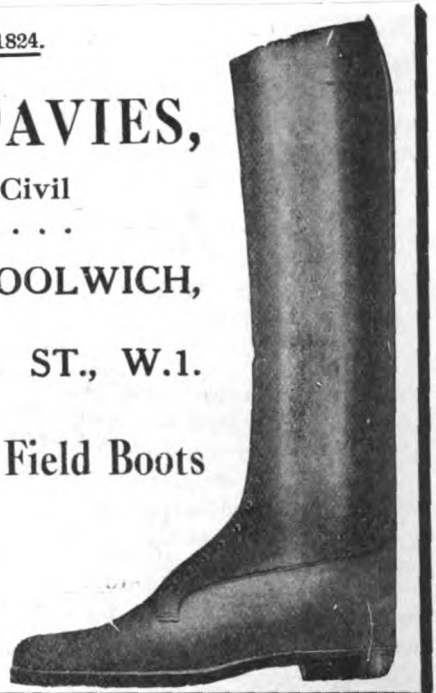

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Will any officers who have had experience of any of these and can supply useful information, or are prepared to criticize such notes as are available, get into touch with the Officer i/c Training Manuals Revision, Room 037, War Office, Whitehall, London, S.W.1.

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DURESCO is not a Distemper, but is a Permanent Benefit to the Surface Coated.

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Durable—alike Inside or Outside.

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The Silicate Paint Co.

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with which is incorporated the business of

Messrs. COX & Co.,

Army and Royal Air Force Agents,
formerly of 16, CHARING CROSS, &c.

Present address: 6, PALL MALL, S.W. 1.

HEAD OFFICE: LONDON, E.C. 3.

(31st December, 1927.)

CAPITAL SUBSCRIBED	£73,302,076
CAPITAL PAID UP	15,810,252
RESERVE FUND	10,000,000
DEPOSITS, &c.	358,662,544
ADVANCES, &c.	187,798,225

The Bank has over 1,750 Offices in England and Wales, and several in India and Burma. It also has Correspondents and Agents throughout the British Isles, and a large number of Colonial and Foreign Agents.

Preparatory School for 40 Boys (7½ to 14)

RED HOUSE, Marston Moor, YORK.

Headmaster (since 1922), LIEUT.-COL. E. N. MOZLEY, D.S.O., R.E. (RET.).

SPECIAL TERMS TO OFFICERS.

Seven Public School Scholarships gained since March, 1925, including two "Firsts" and one "Second."

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In five cases the boy was top in the Higher Mathematical Paper.

Good Health Record. School Farm. Riding, Swimming and Special Outdoor interests.

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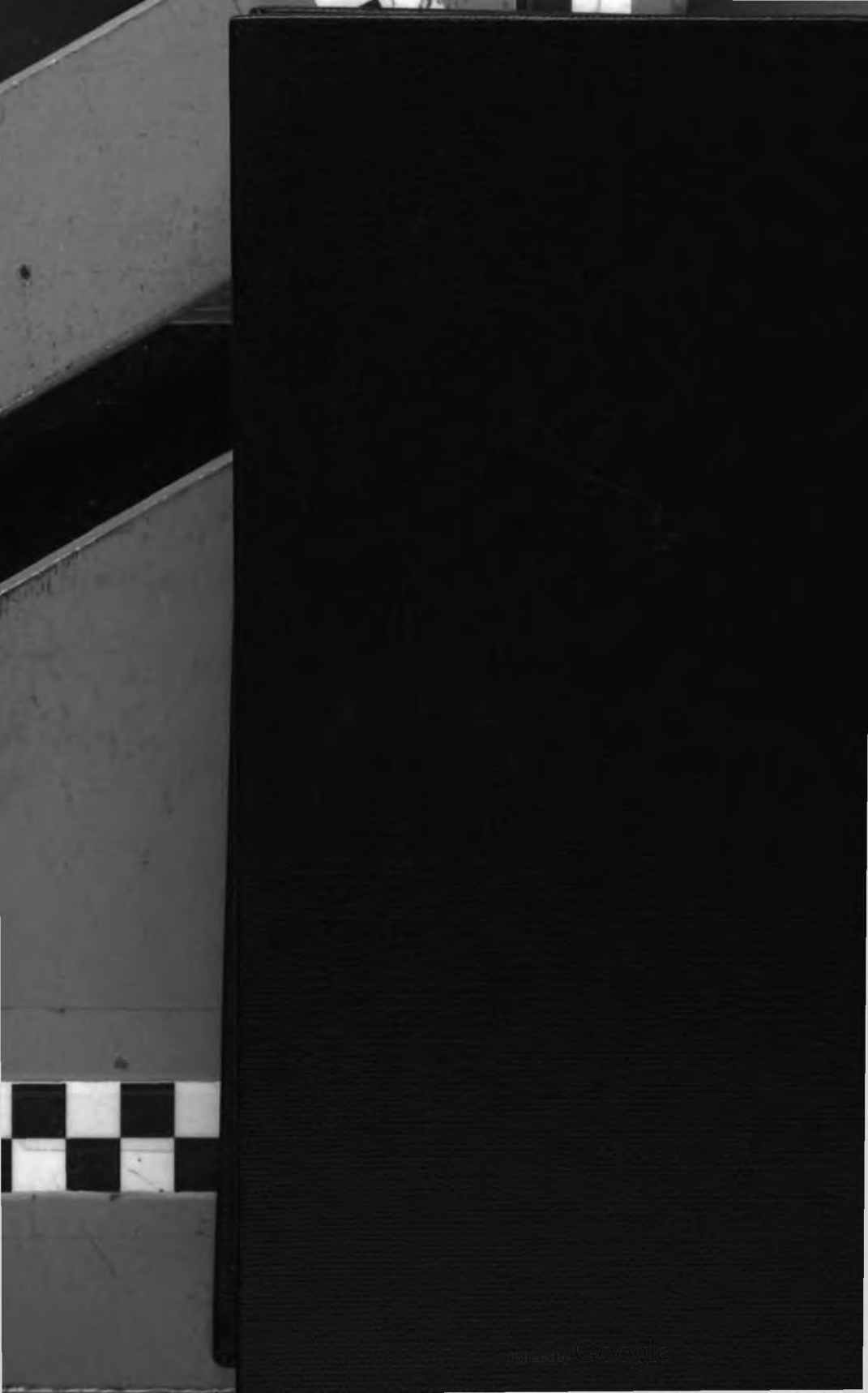

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